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(54) APPARATUS FOR PRODUCING PARTICULATE EFFECTS

(57) An apparatus for producing particulate effects is disclosed comprising a store of particulate material, a feed mechanism to carry particulate material from the store to a chamber. A heater heats particulate material in the chamber, which is then introduced into an outlet tube. A fan provides a flow of gas through the outlet tube. A controller is configured to activate the feed mechanism to move particulate material from the store to the chamber, hold the particulate material in the chamber, activate the heater to heat the particulate material in the chamber, and activate the means for operatively introducing particulate material from the chamber into the outlet tube, whereby heated particulate material is introduced into the outlet tube in a non-continuous manner.

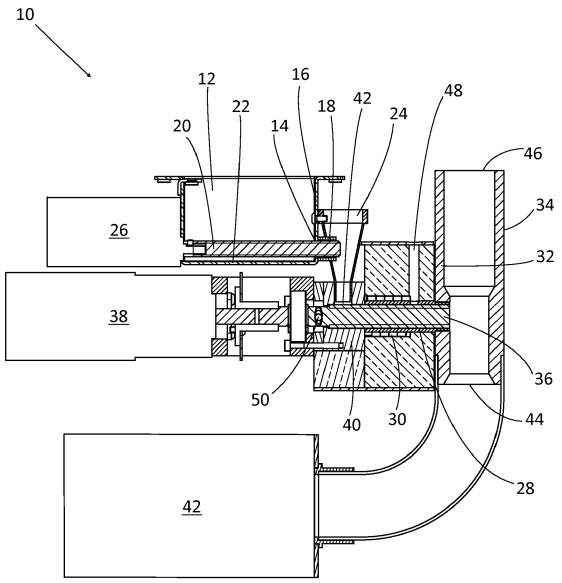

FIG. 1

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Description

Technical Field

[0001] The present disclosure relates to an apparatus for producing particulate effects.

Background

[0002] Pyrotechnic devices are used in the entertainment industry during events such as concerts, festivals, theatrical performances. In many countries, the use of pyrotechnic devices requires a licence because of the dangers associated with pyrotechnics, such as risk of fire. In some instances, the cost and/or time involved in obtaining a licence may prevent the use of pyrotechnics at an event. Recently, devices for producing particulate effects that do not require a licence to use have been developed.

[0003] Chinese utility model CN205784897 discloses a device in which particulate material is stored in a hopper and fed into a venturi tube via a pair of threaded feed rods, each of which is driven by a motor. A heater heats the particulate material to a temperature at which the particulate material will react with oxygen in air and produce light. A fan creates a flow of air in the venturi tube that expels the glowing particulate matter, producing a fountain effect. It would be desirable for devices to produce other effects.

Summary of the Disclosure

[0004] In an aspect of the present disclosure, an apparatus is provided for producing particulate effects. The apparatus comprises a store of particulate material, a feed mechanism operable to carry particulate material from the store to a chamber. The chamber is provided with a heater. The apparatus further comprises an outlet tube, with a source of flowing gas in fluid communication with the outlet tube, and means for operatively introducing particulate material from the chamber into the outlet tube. A controller is configured to activate the feed mechanism to move particulate material from the store to the chamber, hold the particulate material in the chamber, activate the heater to heat the particulate material in the chamber, and activate the means for operatively introducing particulate material from the chamber into the outlet tube, whereby heated particulate material is introduced into the outlet tube in a non-continuous manner.

[0005] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0006] FIG. 1 illustrates a cross-section view of an apparatus for producing particulate effects according to one embodiment of the present disclosure.

Detailed Description

[0007] Reference will now be made in detail to specific embodiments or features, examples of which are illustrated in the accompanying drawings. Wherever possible, corresponding or similar reference numbers will be used throughout the drawings to refer to the same or corresponding parts. Moreover, references to various elements described herein, are made collectively or individually when there may be more than one element of the same type. However, such references are merely exemplary in nature. It may be noted that any reference to elements in the singular may also be construed to relate to the plural and vice-versa without limiting the scope of the disclosure to the exact number or type of such elements unless set forth explicitly in the appended claims.

[0008] FIG. 1 is an illustrative cross-section view of an apparatus 10 for producing particulate effects according to embodiments of the present disclosure.

[0009] The apparatus 10 comprises a hopper 12 in which particulate material may be placed. The hopper 12 has an opening 14 formed in a wall 16 of the hopper 12. A tubular section 18 extends from the wall 16 and surrounds the opening 14. A first threaded rod 20 extends across the hopper 12 near the base 22 and into the tubular section 18. The tubular section 18 opens into a funnel 24. The first threaded rod 20 may be driven by a first motor 26 to feed particulate material from the hopper 12 to the funnel 24 as the first threaded rod 20 rotates. The hopper 12, the first threaded rod 20, the first motor 26 and the funnel 24 together form a store of particulate material.

[0010] Any suitable particulate material may be used. In some embodiments, it is preferred that the particulate material comprises by weight >80% Zr, <2.5% Hf. Preferably, the particulate material comprises particles with a size between 0.2 mm to 1.6 mm. Other elements and compositions of particulate material known to those skilled in the art may be used.

[0011] The apparatus 10 further comprises a chamber 28, which is provided with a heater 30. The chamber 28 extends into a side wall 32 of an outlet tube 34.

[0012] A feed mechanism is operable to carry particulate material from the store to the chamber 28. In the embodiment, the feed mechanism comprises a second threaded rod 36 driven by a second motor 38. The second threaded rod 36 extends through a feed channel 40. The feed channel 40 has an opening 42 which is in communication with the funnel 24 such that particulate material in the funnel 24 falls into the feed channel 40 via the opening 42. The chamber 28 is connected to the feed channel 40 such that as the second motor 38 drives the second threaded rod 36, particulate material is carried into the chamber 28.

[0013] The heater 30 may be any suitable form of heating, such as a resistive heating element or an inductive heater. Other heating methods may also be used, such as a flame. The heater 30 is operable to heat the partic-

ulate material in the chamber 28. In the embodiment, the heater 30 may heat the particulate material to a temperature of more than 300 degree C, and preferably between 350-450 degrees C. In the embodiment illustrated in FIG. 1, the heater 30 is a resistive heating element that is wound around the chamber 28.

[0014] The apparatus 10 further comprises means for operatively introducing particulate material from the chamber 28 into the outlet tube 34, which in the embodiment takes the form of the second threaded rod 36 extending through the chamber 28 to also carry particulate material from the chamber 28 into the outlet tube 34.

[0015] A source of flowing gas, which in the embodiment is a fan 42, is provided in fluid communication with a lower end 44 of the outlet tube 34. The fan 42 creates a stream of flowing air that passes up the outlet tube 34 and exits at an upper end 46 thereof. The flowing air creates a Venturi effect to assist particulate material to enter the outlet tube 34 from the chamber 28. Particulate material from the chamber enters the outlet tube 34 and is carried up and out of the outlet tube along with the flowing air. Since the particulate material from the chamber is hot, it reacts with oxygen in the air to glow and thus create a particulate effect upon leaving the outlet tube 34.

[0016] In other embodiments, other sources of flowing gas may be employed, such as a vessel of compressed gas operable by an output valve. A compressor may be used to pressurize gas in the vessel, and may be operable by the controller.

[0017] In the embodiment, the chamber 28 has an aperture 48 formed in it adjacent to the outlet tube 34. The aperture 48 allows air to enter the chamber 28 and begin reacting with the heated particulate material prior to it entering the outlet tube 34. It has been found that this enhances the particulate effect by allowing more time for the particulate material to react and begin to glow prior to being expelled from the outlet tube 34. Locating the aperture 48 after the heater 30 ensures the particulate material is at the desired temperature prior to beginning to react with air introduced via the aperture 48.

[0018] In the embodiment, the second threaded rod 36 includes a thermal barrier near an end coupled to the second motor 38. Since the threaded rod extends through the chamber in the embodiment, and is in thermal contact with the heated particulate material in the chamber, the thermal barrier reduces heat flow into the second motor 38. In one form, the thermal barrier may consist of holes 50 formed in the threaded rod. Another suitable thermal barrier may be a low thermal conductivity section in the rod, such as a section formed of ceramic material.

[0019] The apparatus 10 further comprises a controller (not shown), which may take any suitable form such as a discrete logic and PID control circuits, programmable logic controller (PLC), embedded controller, microcontroller or microprocessor, or a combination of these. The first and second motors 26 and 38, and the fan 42 or other source of flowing gas are operable in response to signals from the controller.

[0020] The controller is configured to generate signals to operate the first motor 26 to carry particulate material from the hopper 12 to the funnel 24. The controller is further configured to generate signals to operate the second motor 38 to carry particulate material from the funnel 24 to the chamber 28. The controller then generates signals to stop the second motor 38 so that particulate material is held in the chamber 28.

[0021] The controller is also configured to generate signals to operate the heater 30 to heat the particulate material in the chamber 28. The controller may generate signals to operate the heater 30 according to any suitable control method, including operating the heater 30 for a predetermined time once the particulate material is held in the chamber 28. Alternatively, a thermocouple or other temperature sensor may be used to provide a control signal used by the controller to operate the heater 30. The temperature sensor may be situated in the chamber 28 wall near the particulate material, or in any other suitable position to provide a control signal corresponding to the particulate material temperature.

[0022] The controller is also configured to generate signal to operate the fan 42. The fan 42 is preferably a variable speed fan, although a fixed-speed fan may be used. The controller may generate signals to operate the fan at any preferred speed according to requirements. In some embodiments, the controller may be configured to operate the fan whenever the apparatus 10 is operating.

[0023] When the controller determines that the particulate material is heated sufficiently, whether by temperature sensor or timed operation of the heater 30 as described above, and the controller further determines that the fan 42 is operating at a desired speed, the controller may then generate signals to introduce particulate material from the chamber 28 into the outlet tube 34 to produce a particulate effect. In some embodiments, the controller may wait for a command signal before generating signals to introduce particulate material from the chamber 28 into the outlet tube 34.

[0024] In the embodiment, the controller generates signals to operate the second threaded rod 36 to introduce particulate material from the chamber 28 into the outlet tube 34.

[0025] One or both of the motors 26 and 38 may be variable speed motors. It will be appreciated by those in the art that the controller may be configured to operate the motors 26 and 38 at different speeds. Further, the motor 38 may be operated at different speeds, which may alter the appearance, size or duration of the particulate effect.

[0026] In an alternative embodiment to that shown in FIG. 1, the second threaded rod may not extend through the chamber. In this alternative embodiment, the second threaded rod is part of the feed mechanism but is not part of the mechanism for introducing particulate material from the chamber into the outlet tube. A valve, such as a butterfly valve, may be provided between the chamber and the outlet tube. This valve may be operable by the

controller such that when the valve is open, the air or other gas flowing through the outlet tube creates a venturi effect that acts to draw the particulate material into the outlet tube.

[0027] The alternative embodiment separates the carrying of particulate material from the store to the chamber, and the introduction of the particulate material from the chamber to the outlet tube. One benefit of this arrangement is that the second threaded rod is not in thermal contact with the heater, which is located at the chamber. This may reduce the heat that in turn passes to the second motor, increasing its operating life. It also allows the particulate material to be held in the chamber at a desired temperature without heat passing along the second threaded rod and into the motor. In some arrangements, this may eliminate the need for the first threaded rod and the first motor, whereby the second threaded rod is provided in the hopper and feeds particulate material directly to the chamber therefrom. Such an arrangement is not practical in the embodiment shown in FIG. 1 - the first and second threaded rods 20, 36 are present to prevent heat from the heater 30 from heating particulate material in the hopper 12.

[0028] A further benefit of this alternative embodiment is that the controller can adjust the amount of particulate material in the chamber by controlling the second motor. Further, the valve may allow adjustment of the rate of introduction of the particulate material into the outlet tube from the chamber, by altering the extent to which the valve is opened. In contrast, in the embodiment shown in FIG.1, the rate of introduction is fixed for a given speed of the second motor, which ultimately places limits on the rate of introduction. Use of a valve may permit a greater range, and a higher maximum rate of introduction of particulate material into the outlet tube, permitting a greater range of effects.

[0029] Various embodiments disclosed herein are to be taken in the illustrative and explanatory sense, and should in no way be construed as limiting of the present disclosure.

Industrial Application

[0030] It will be appreciated that embodiments of the present disclosure provide an apparatus for producing particulate effects that may offer the ability to create new effects compared with devices currently available. In particular, by introducing particulate material into the outlet tube in a non-continuous manner, embodiments of the disclosure may offer the ability to create a burst-like effect.

[0031] It will be appreciated by those in the art that embodiments of the present disclosure may also be operated in a continuous mode.

[0032] While aspects of the present disclosure have been particularly shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed machines, systems and methods without departing from the spirit and scope of what is disclosed. Such embodiments should be understood to fall within the scope of the present disclosure as determined based upon the claims and any equivalents thereof.

Claims

1. An apparatus for producing particulate effects, comprising:

   a store of particulate material;
   a feed mechanism operable to carry particulate material from the store to a chamber, the chamber being provided with a heater;
   an outlet tube, a source of flowing gas in fluid communication with the outlet tube;
   means for operatively introducing particulate material from the chamber into the outlet tube;
   a controller configured to activate the feed mechanism to move particulate material from the store to the chamber, hold the particulate material in the chamber, activate the heater to heat the particulate material in the chamber, and activate the means for operatively introducing particulate material from the chamber into the outlet tube whereby heated particulate material is introduced into the outlet tube in a non-continuous manner.

2. The apparatus of claim 1, wherein the feed mechanism comprises a threaded rod driven by a motor, the threaded rod being provided in a feed channel, the feed channel being connected to the chamber, the threaded rod extending between the store and the outlet tube through the feed channel and chamber, the chamber extending into the outlet tube, and wherein the means for operatively introducing comprises the threaded rod and motor.

3. The apparatus of claim 1, wherein the feed mechanism comprises a threaded rod driven by a motor, the threaded rod being provided in a housing and extending between the store and the chamber, wherein the chamber is separate from the rod.

4. The apparatus of claim 3, wherein means for operatively introducing particulate material comprises a valve provided between the chamber and the outlet tube.

5. The apparatus of any of claims 1 to 4, wherein the source of flowing gas comprises a fan.

6. The apparatus of any of claims 1 to 4, wherein the source of flowing gas comprises a vessel of com-

pressed gas and an output valve.

7. The apparatus of claim 6, wherein source of flowing gas further comprises a compressor operable to compress gas in the vessel.

8. The apparatus of any of claims 1 to 7, wherein the particulate material comprises particles with a size between 0.2 mm to 1.6 mm.

9. The apparatus of claim 8, wherein the particulate material comprises at least 80% by weight of Zr.

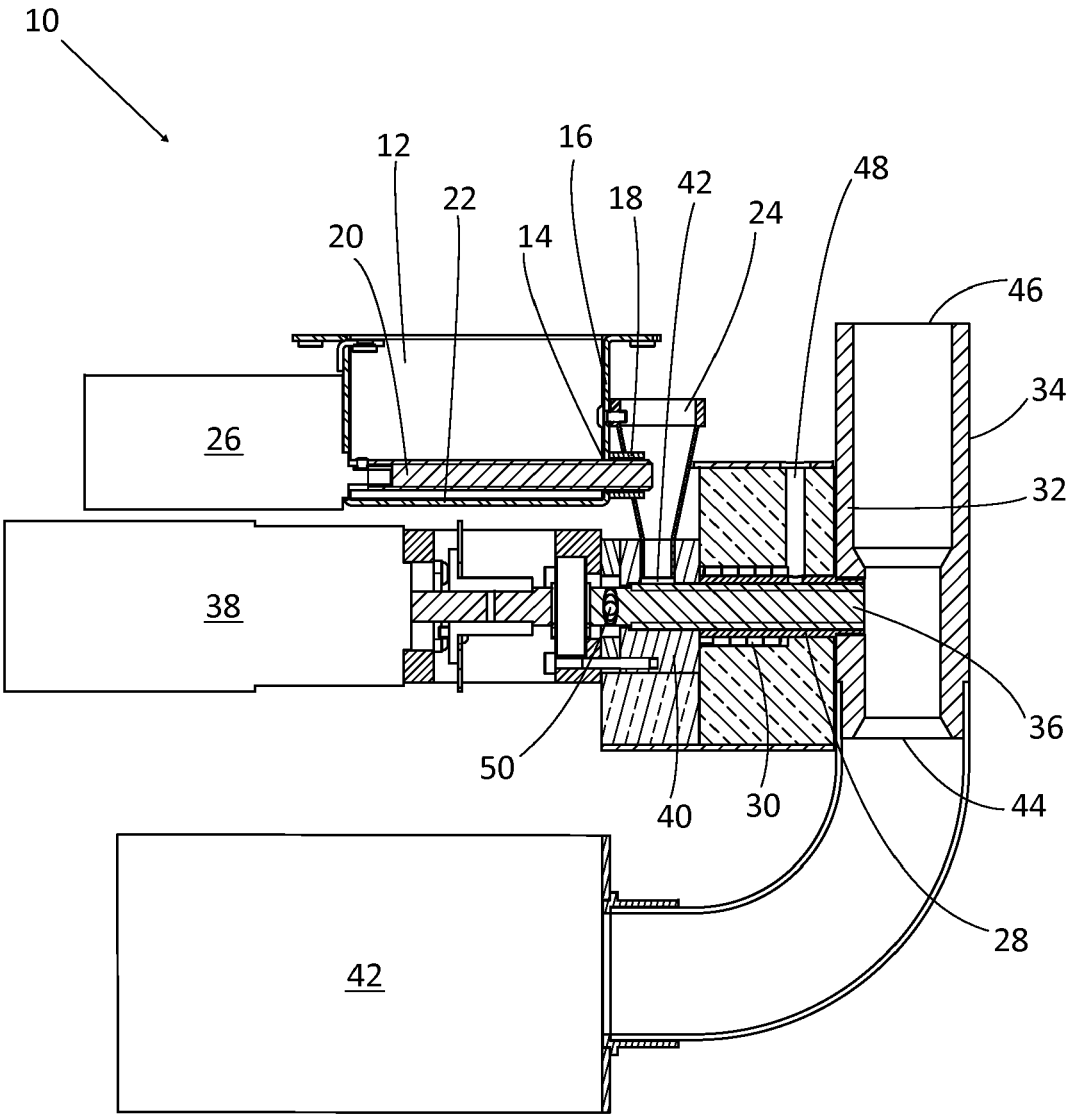

FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 4312

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	CN 205 784 897 U (LIUYANG XIAOWEN ELECTRONIC TECH CO LTD) 7 December 2016 (2016-12-07)	1-3,5-9	INV. F42B4/26 F42B4/18
Y	* paragraphs [0022], [0024], [0030], [0034], [0036] * * figure 1 *	4	

Y	GB 321 172 A (HARALD NIELSEN; BRYAN LAING) 1 November 1929 (1929-11-01) * page 1, lines 9-10 * * page 4, lines 10-30 * * figure 1 *	4	

TECHNICAL FIELDS SEARCHED (IPC)

F42B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 September 2017	Van Leeuwen, Erik

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 205784897 U	07-12-2016	NONE	
GB 321172 A	01-11-1929	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Patent documents cited in the description

- CN 205784897 **[0003]**