FIG. 3

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The present invention relates to fabric gas cleaning devices and more particularly to improved fabric tube type dust collectors and an improved method of operating the same.

Gas pervious fabric tube type dust collectors have long been known in the gas cleaning industry as effective in removing various industrial air pollutant materials. Dirty gas streams to be treated have been passed through gas pervious fabric tube collectors so that contaminant particles in the streams have been removed by the gas pervious fabrics, the contaminant particles collecting in cakes on the internal surfaces of the fabric tubes. To periodically remove collected contaminant particles from the tubes so as to maintain appropriate gas cleaning efficiencies, the fabric tubes have either been shaken with complex and expensive shaker mechanisms or have been collapsed and reinfalated to break and dislodge the cakes of contaminant particles. In those instances where the tubes have been collapsed and reinfalated in order to accomplish sufficient contaminant particle removal, it has been the practice to so reinfalate the tubes that the reinfalation cycle terminates with a violent "snapping" or "popping" action. Although past arrangements for collapsing and reinfalating the fabric tubes have proven reasonably efficient when compared with shaker type tube cleaners, the present invention recognizes that these past arrangements also have had their disadvantages. For one, the sudden "snapping" or "popping" at the end portion of a tube cleaning cycle has caused many of the contaminant particles that have been collected by the tubes to be forced through the tubes rather than be released thereof, these contaminant particles being entrained in the clean gas stream during subsequent operations. Moreover, the aforesaid described "snapping" or "popping" has resulted in decided tube wear and in wear of the supporting mechanism for the tubes. This wear has led to reduction in cleaning efficiency and has resulted in costly and time consuming repairs and replacements.

In accordance with the present invention, an improved fabric tube type dust collector and an improved method of operating the same is provided. The arrangement of the present invention avoids the abovementioned disadvantages to provide a gas cleaning device which can be utilized where greater efficiencies are desired and where high temperature operation is a factor, such as in the cement, steel or carbon industries. With the arrangement of the present invention, thorough tube flexing during tube cleaning operations is obtained without the violent shaking which has brought about fabric damage and which has reduced tube life. Further, such thorough tube shaking is accomplished in a minimum of time and without the expensive and space consuming equipment required in the past.

Various other features of the present invention will become obvious to one skilled in the art upon reading the disclosure set forth hereinafter. More particularly, the present invention provides a full inflation for particular applicability in industrial dust collection where contaminant particle concentration and particle sizes are generally large, the present invention also can be utilized in gas cleaning conditions when particle concentration and particle sizes are less—for example, in atmospheric filtration.

Referring to the drawings:

FIGURE 1 is a partially broken, exploded, elevational view of a gas pervious fabric tubular collector housing in which the inventive improvement is incorporated;

FIGURE 2 is an isometric view of the base support structure for the collector housing of FIGURE 1; and,

FIGURE 3 is a schematic diagram of electrical circuitry incorporating the inventive improvement for operating the tubular collector structure of FIGURES 1 and 2.

Referring to FIGURE 1 of the drawings, tubular collector, interrupting the flow of the dirty gas stream through the collector, passing a clean gas stream in a reverse direction through the collector at a sufficient pressure and velocity to at least partially collapse the collector and crack the contaminant cake thereon, resuming the flow of the dirty gas stream in the first direction through the fabric collector for a time period less than that required to fully reinflate the collector but at sufficient pressure and velocity to allow the collector to inertially fully reinflate in a softly fluttering manner after the reverse flow of the gas stream has been interrupted, and interrupting the resumed flow of the dirty gas stream to bring about such inertial reinflation of the fabric collector, the period of dirty gas stream flow interruption being maintained a sufficient time to permit such fabric fluttering with concomitant cracking, dislodging and gravity removal of contaminants from the fabric collector. In addition, the present invention provides a novel apparatus for carrying out the aforesaid method, such apparatus including a housing having a dirty gas inlet, a reverse flow outlet and a clean gas outlet, gas pervious fabric tubular collector means resiliently mounted in the housing, the tubular collector means having a dirty gas inlet and a reverse flow outlet of the housing, a first damper for the dirty gas inlet of the housing, a second damper for the reverse flow outlet of the housing, and control means for the first and second dampers, the control means including a first timer arranged to cause the closing of the primary damper for a preselected period of time to shut off passage of dirty gas through the dirty gas inlet of the housing and through the tubular collector means, a second timer arranged to cause the opening of the second damper for a preselected period of time when the first damper is closed to permit clean gas to pass through the tubular collector means to the reverse flow outlet of the housing thereby at least partially collapsing the collector means to initially dislodge contaminant particles collected thereon and a third timer arranged to cause the closing of the primary damper for a preselected period of time shortly after the first and second timer has timed out and before the filter tube means has been fully inflated whereby the tubular collector means inertially moves toward full inflation with accompanying fluttering movement to further crack and dislodge contaminant particles collected thereon.

It is to be understood that various changes can be made in the shape, form and construction of the apparatus disclosed herein and in the several steps of the method disclosed herein without departing from the scope or spirit of the present invention. For example, although the present disclosure sets forth an "upflow" arrangement for tube type dust collector, it is to be understood that the features of the invention also can be incorporated in a "downflow" arrangement. It further is to be understood that, although the present invention finds particular applicability in industrial dust collection where contaminant particle concentration and particle sizes are generally large, the present invention also can be utilized in gas cleaning conditions when particle concentration and particle sizes are less—for example, in atmospheric filtration.
lector housing 2 is disclosed as including a dirty gas inlet section 3, tube section 4, clean gas outlet section 5 having a clean gas outlet 10, hopper section 6 and damper section 7. As can be seen in FIGURE 2 of the drawings, a suitable housing base support section 8 is provided to support the aforementioned housing 2.

In the embodiment of the invention disclosed, dirty gas inlet section 3 is divided into four separate compartments by suitable partitions (not shown in detail) so that each compartment has a dirty gas inlet aperture 9 and a reverse gas inlet aperture 9. It is to be understood that the present invention is not to be considered as limited to the number of sections disclosed, the number of sections utilized depending upon such factors as the size of the unit, the number of tubes involved, and the particular results desired in a specific application. Hopper section 6 which is positioned below dirty gas inlet section 3 in communicable relationship therewith, is arranged to communicate with each of the compartments in section 3 and, as disclosed, includes a pair of rotary valves 12, 13 which can be timed to open and close in a preselected manner in accordance with the gas cleaning operations that are described hereinafter.

To control flow of a dirty gas stream through each of dirty gas inlet apertures 9 and into the separate compartments of dirty gas inlet section 3, solenoid controlled pneumatic damper sections 7 are provided. In the drawings, only one damper section 7, capable of handling two compartments, is disclosed. It is to be understood that a similar damper section (not shown) is provided for the other two compartments disclosed. Damper sections 7 each include a pair of primary dampers 14, each of which cooperates with a dirty gas inlet 9 of a compartment in section 3. In similar fashion, damper sections 7 also are provided with a pair of secondary dampers 16, each of which controls the reverse outlet flow of gas through a gas reverse flow aperture 11 of a compartment in section 3. In this connection it is to be noted that each damper section 7 is provided with a dirty gas inlet duct 17 upstream of dampers 14 and a gas reverse flow duct 18 downstream of dampers 16. Suitable blower mechanism (not shown) is provided to move dirty gas through duct 17, apertures 9, into the compartments of section 3 and through the gas pervious fabric tubes of section 4. In like fashion, suitable reverse blower mechanism (not shown) is provided to move clean gas in a reverse direction through the tubes of section 4, through the compartments of section 3, through reverse flow outlets 11 and duct 18. It is to be understood that dampers 14 and 16 of each damper section 7 can be pneumatically actuated through a solenoid controlled pneumatic system in a novel preselected manner as described hereinafter (FIGURE 3).

Referring again to FIGURE 1 of the drawings, it can be seen that tube section 4 communicates with dirty gas inlet sections 3 through a plurality of apertures 19 disposed in header plate 21 extending across the lower portion of tube section 4. Each aperture 19 is surrounded by a thimble or sleeve 22 so that the lower end of each tube 23 can be fastened to such sleeve with the aid of a draw band clamp 24 (not disclosed in detail). Tubes 23, which can be fabricated from any one of a number of suitable gas pervious materials and which advantageously are made from a fibrous glass material capable of resisting temperatures as high as 550° F., are each closed at their upper ends by means of a cap 26, the upper end of the tubes being flanged in the cap with the aid of a suitable flange band clamp 27. To maintain the tubes in vertically extending, substantially parallel position in tube section 4, horizontal support grating 28 is provided across the upper portion of tube section 4. Each tube 23 is suspended from support grating 28 through a chain 29 fastened at one end to the grille and at the other end of each chain 29 is fastened to a spring 32, which in turn is fastened to the cap 26 on which an end of tube 23 is mounted. It is to be understood that the chain, spring and tube are so sized that the spring maintains the tube under a preselected resilient tension during gas cleaning operations, the tension being adjusted to permit the inventive tube cleaning operations hereinafter described.

Referring to FIGURE 3 of the drawings, an advantageous circuit is disclosed for accomplishing preselected actuation of the solenoid valves (not shown) in pneumatically operated damper sections 7 and thus the tube cleaning operations of the aforesaid apparatus in a manner heretofore unknown in the art of gas cleaning. This circuit includes a main supply line L1-L2 adapted to receive a suitable voltage, advantageously 115 volts, from a suitable, appropriately fused step-down transformer (not shown). With “On-Off” switch S15 in closed position, cam timer CT connected across line L1-L2 is energized to be driven so as to close normally open contact CT1 for a preselected length of time four times each cycle of the cam timer CT. Thus, the time circuit TD1, TD2, TD3 is energized four times during such cycle of the cam timer. At the same time, cam timer CT serves to drive, through a suitable chain linkage, a cam programming device (not shown) which serves to successively close in preselected intervals normally open switches CT1a, CT2b, CT3, and CT4 successively so that each compartment can be successively operated by the timer system TD1, TD2, TD3, as described hereinafter. When cam timer CT is moved to the first position where normally opened contact CT1a is closed and normally open contact CT2a for one section is closed through the cam programming device linked with the cam timer CT, gas cleaning operations for that section—which have been at a sufficient pressure and velocity to collapse tube 23—become energized. With CT1a energized, the two normally open contacts CR1a are closed. With contacts CR1a closed, the primary damper solenoid relay PDR1 for that section is energized, as is the reverse damper solenoid relay RDR1 for that section. With these relays energized, primary damper 14 for that section closes off its dirty gas inlet 9 to stop passage of the dirty gas stream through the compartment and through tubes 23 connected with the compartment. At the same time, secondary damper 16, controlled by relay RDR1, is moved to open position to open aperture 11 and the reverse flow of clean gas under suitable pressure conditions. It is to be understood that this reverse flow of clean gas is at a sufficient pressure and velocity to collapse tubes 23—become energized. The length of time that the primary damper 14 is closed and the secondary damper 16 is open is preselected by timers TD1 and TD2. The timer TD1 after it times out allows normally closed contact TD1c to open and the timer TD2 allows normally closed contact TD2c to operate to energization of solenoid relays PDR1 and RDR1. The position of the dampers 14 and 16 of that section are then reversed, with the primary damper 14 opening and the secondary damper 16 closing. Tubes 23 in that section then commence to reinflate. At this point, it is to be noted that at the same time that timers TD1 and TD2 are running a third timer TD3 also is running. Timer TD3 is set to run for slightly longer preselected period of time than timers TD1 and TD2. As soon as timer TD3 has run its preselected course, normally open contact TD3c closes and, as a result of this action, solenoid relay PDR1 again is energized. This in effect causes primary damper 14 to again be closed for a short preselected period of time, the damper 14 remaining closed until contact TD2c energizes, thus ensuring a resulting opening of the circuit. Thus, in effect, primary damper 14 is closed on the reinflation cycle for a short,
null period of time. The setting of timer TD3 is such that the null period commences at a point just before tubes 23 of the section are fully reinflated. Because of the inertial motion that is imparted to the tubes during the reinflation cycle by the dirty gas under suitable pressure and velocity, the tubes proceed to full inflation after the null period commences with a gentle fluttering motion that further cracks the cake of contaminant particles on the tubes and yet avoids heretofore known "snapping" or "popping" action of the tubes. It is to be noted that the null period initiated by timer TD3 before contact CT6 opens is sufficient to allow dislodged contaminant particles to settle from the tubes into hopper section 6. Once contact CT6 opens, the tube shaking period for that section is complete. Damper 14 then opens again to permit further treatment of the dirty gas stream by the cleaned tube section. After a preselected period of time, cam timer CT rotates to a second position. This again results in closing of contact CT6 for a preselected period of time. In the meantime the cam programming device coupled to cam timer CT has moved to a second position to close contacts CT9 and the tubes of a second section are cleaned in a similar manner. And so, in like sequential fashion, the tubes for the third and fourth section are cleaned and the entire, overall cycle repeated.

The invention claimed is:

1. A method of collecting contaminant particles from a dirty gas stream including the cycle steps of passing such dirty gas stream into an open end of and through the walls of a gas pervious fabric tubular collector at a first pressure and velocity sufficient to maintain said fabric tubular collector in inflated form with contaminant particles in such dirty gas stream collecting on the inner surface of the walls of said fabric tubular collector; thereafter cleaning the collector in a cleaning cycle comprising stopping the flow of said dirty gas stream into said fabric tubular collector when a cake of contaminant particles has collected on the inner surface of the walls thereof; passing a clean gas stream in a reverse direction through said fabric tubular collector at sufficient pressure and velocity and for a preselected time interval during the cleaning cycle to at least partially collapse said fabric tubular collector and to crack the contaminant cake collected thereon; resuming the flow of said dirty gas stream into said open end and through said fabric tubular collector at the first pressure and velocity for a time period less than that required to reinflate the collector; stopping the resumed flow of said dirty gas into said collector at a point prior to full fabric tubular collector reinflation to allow said collector to inertially fully reinflate in a softly fluttering manner; stopping the clean gas stream at a preselected point during said cleaning cycle; and resuming the flow of said dirty gas stream into and through said collector at the end of said cleaning cycle after said fabric tubular collector has inertially fully reinflated.

2. The method of claim 1, including the step of maintaining said fabric tubular collector under resilient tension to facilitate inflation and collapse thereof.

3. Apparatus for collecting contaminant particles from a dirty gas stream comprising a housing having a dirty gas inlet means, a reverse flow outlet means, and a clean gas outlet means, gas pervious fabric tubular collector means resiliently mounted in said housing, said collector means having a dirty gas inlet communicably connected with said dirty gas inlet means and reverse flow outlet means of said housing, a first damper means constructed and arranged to control flow through said dirty gas inlet means of said housing, a second damper means constructed and arranged to control flow through the reverse flow outlet means of said housing, and control means operatively connected to said first and second damper means, said control means including first, second and third timer means and an actuating means operatively connected to said first, second and third timer means, said first timer means being connected to said first damper means to close said first damper means for a preselected period of time when said first timer means is actuated to shut off passage of dirty gas through said dirty gas inlet means, said second timer means being connected to said second damper means to open said second damper means for a preselected period of time while said first damper means is closed by said first timer means to permit clean gas to pass through said fabric tubular collector means and said reverse flow outlet means of said housing to at least partially collapse said fabric tubular collector means and crack the contaminant particle coat collected thereon, said first damper means opening and said second damper means closing after said first timer means and said second timer means time out so as to resume dirty gas flow passage through said collector means; said third timer means being operatively connected to said first damper means to again close said first damper means shortly after said first timer means has timed out and before said tubular collector means has fully inflated to permit said collector means to inertially move toward full inflation with an accompanying fluttering movement to further crack and dislodge the contaminant particle coat thereon, said control means further being operatively connected to said first damper means to open said first damper means to resume passage of dirty gas through said collector means after said collector means has fully inflated, said second timer means has timed out at a preselected point with said second damper means closing and the dislodged contaminant particles have settled out.

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