United States Patent [19]

Sutter

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[54] **METHOD OF AND APPARATUS FOR AUTOMATIC CLEANING OF AN AIR FILTER**

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[51] **Int. Cl.** **B01d 46/04**

[58] **Field of Search** ..... 55/283, 284, 286–288, 55/292, 293, 301–303, 307, 431, 273, 99, 27, 272, 96, 467, 471, 314; 57/56; 15/300 R, 352

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[57] **ABSTRACT**

A method of and apparatus for automatically cleaning an air filter wherein a working air current containing contaminants is guided in a predetermined direction through the air filter, then during the cleaning of the filter impinging the filter with a cleaning air current which flows in a direction opposite to the direction of flow of the working air current. The cleaning air current impinges the filter in the form of a shock wave, and the energy of the shock wave is derived from the working air current.

12 Claims, 4 Drawing Figures

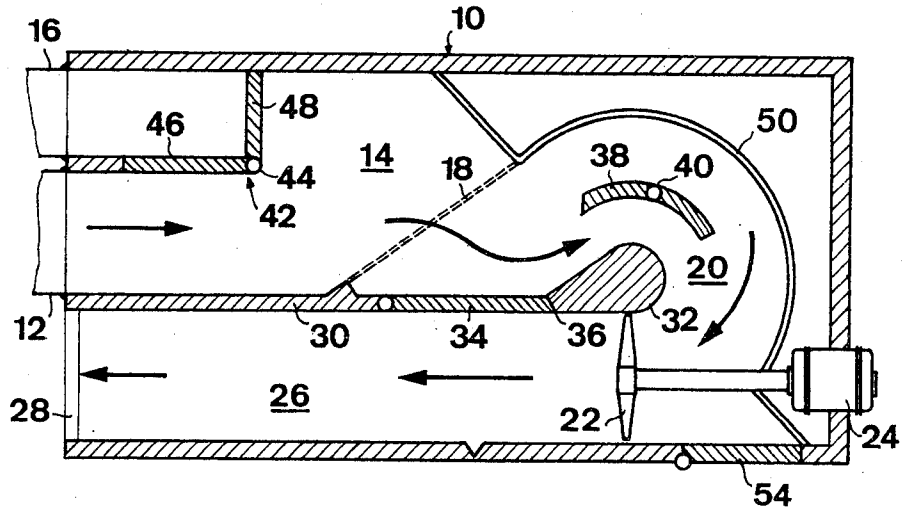

Fig. 1

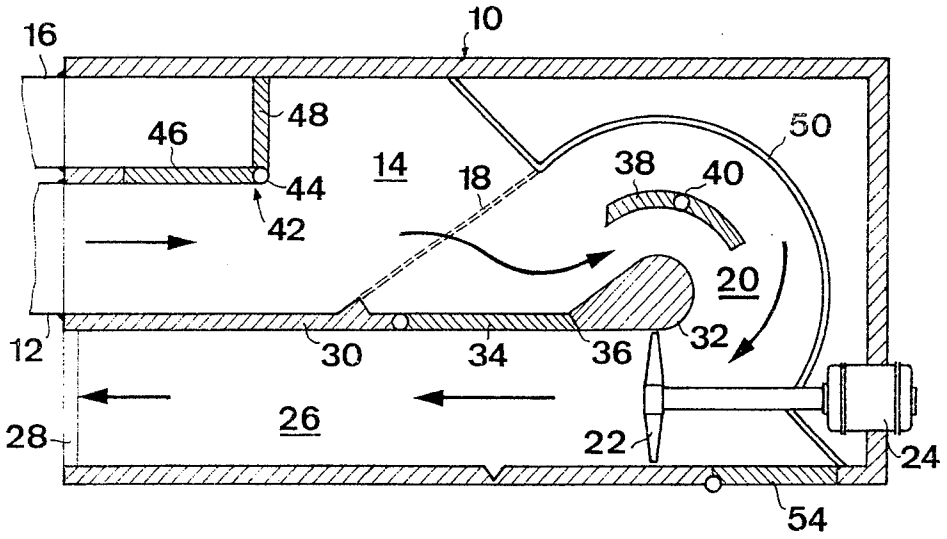
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Fig. 2

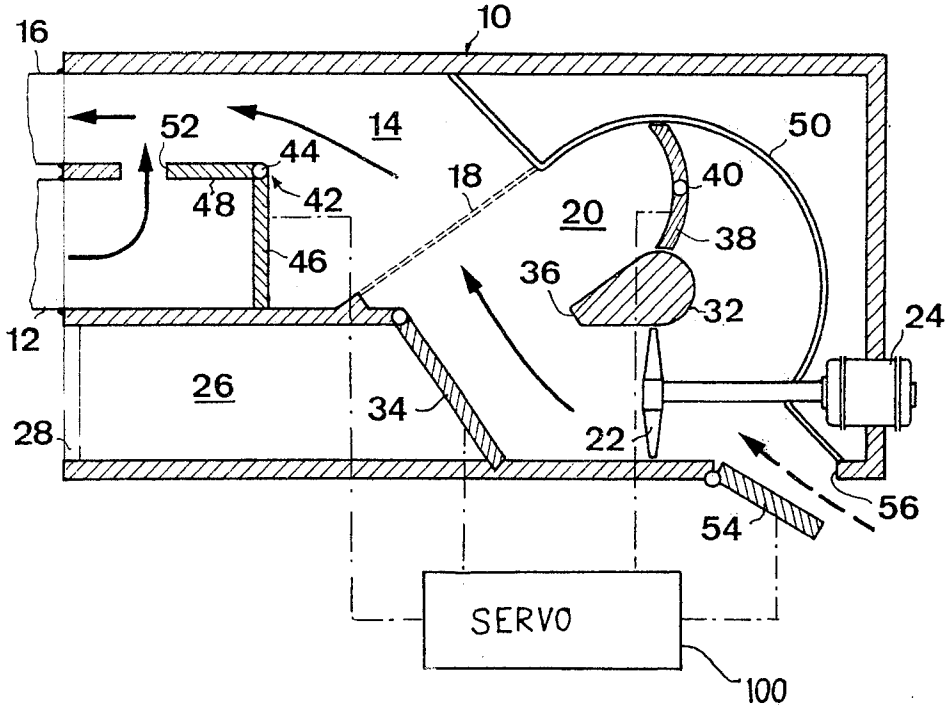
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Fig. 3

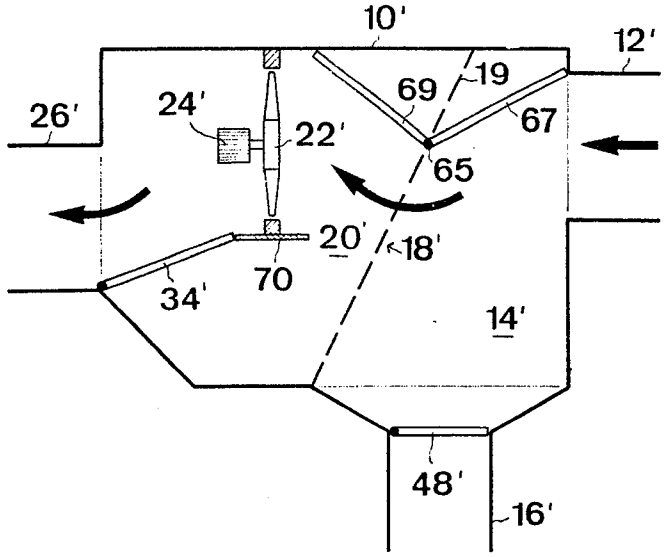
10'
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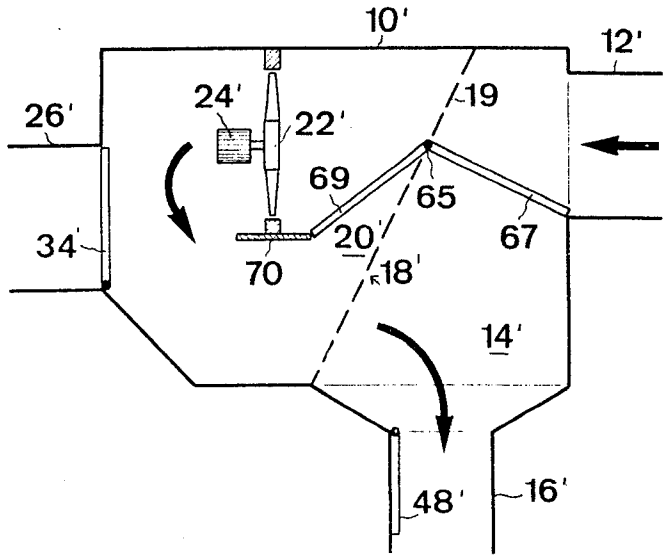
Fig. 4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METHOD OF AND APPARATUS FOR AUTOMATIC CLEANING OF AN AIR FILTER

BACKGROUND OF THE INVENTION

The present invention relates to a new and improved method of, and apparatus for, automatically cleaning an air filter.

Techniques and equipment for automatically cleaning filters have been known for quite some time in the textile art. These techniques and equipment are known, for instance, in conjunction with the filters of pneumatic cleaning devices and suction installations of textile machines as well as the air conditioning installations of textile machinery rooms.

Methods are known to the art in which, instead of cleaning the filter with mechanical means, such as for instance with scrapers or strippers, the fibers and dust are detached from the filter by an air current. With a number of such state-of-the-art methods, the air current serving for cleaning purposes is guided in a direction through the filter which is opposite to the direction of the working air current of the suction device. However, the flow of the working air current through the filter must be briefly interrupted so that the fibers collected at its so-called raw air side can be detached by means of the cleaning air current which passes through the filter from the clean air side. In order to maintain operation of the suction installation also during the cleaning of the filter and simultaneously withdrawing the contaminants or foreign particles detached from the filter, it has already been proposed to connect to the raw air side of the filter the suction side of an auxiliary air conveying mechanism which is only effective during the cleaning phases.

Depending upon the type of textile machine to which the filter is connected as well as the type of material processed in this machine, this technique is capable of more or less completely cleaning the filter. However, in a great many other situations the cleaning action is insufficient, causing the suction installation to continuously operate uneconomically, although the cleaning operation is carried out periodically.

SUMMARY OF THE INVENTION

Hence, it is a primary object of the present invention to provide an improved method of, and apparatus for, reliably and effectively cleaning air filter, wherein simultaneously the duration of the cleaning phase is shortened.

Now in order to implement this, and further objects of the invention which will become more readily apparent as the description proceeds, the method of this development for the automatic cleaning of an air filter contemplates guiding a working air current containing the contaminants in a predetermined direction, and the filter is impinged during the cleaning operation by a cleaning air current which flows in a direction opposite to the direction of flow of the working air current. According to the invention, the cleaning air current acts at the filter in the form of shock or surge waves and the energy of the shock waves are derived from the working air current.

The method aspects of this development can be carried out in an extremely simple manner in that the cleaning operation can be directly derived from the normal filter operation. It is only necessary to have a

sudden deflection of at least a part of that air which has already flown through the filter as working air.

It is of importance that the shock wave is produced at the neighborhood of the filter, wherein it can be also advantageous if the degree of expansion thereof at the clean air side of the filter is maintained at a minimum or in fact can be influenced.

The invention is not only concerned with the aforementioned method aspects, but also relates to a new and improved construction of apparatus for the performance of the inventive method, and such apparatus comprises a filter housing, an air filter which divides the filter housing into a raw air compartment and a clean air compartment, an inlet opening connected to the raw air compartment, a blower or ventilator coupled by means of its suction side with the clean air compartment, and deflecting means which selectively connects the pressure side of the blower with the atmosphere or with the clean air compartments. Furthermore, the inventive apparatus incorporates switching means in order to at least partially shut-off the suction side of the blower with respect to the clean air compartment and also incorporates means for simultaneously actuating the shut-off means together with the deflecting means.

These measures enable limiting the expansion of the shock wave within the clean air compartment, and it is also possible to completely prevent an expansion in the compartment connected with the suction side of the blower. The shut-off means are preferably formed by a flap member which is coupled with the deflecting means, and there is provided a common actuation element. This actuation element is preferably a servomotor which can be actuated by compressed air and is capable of suddenly controlling or switching the shut-off means and deflecting means.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. **1** illustrates in horizontal sectional view a first exemplary embodiment of a filter box or housing of a suction installation in the normal position of the equipment;

FIG. **2** illustrates the filter box or housing of FIG. **1** in the cleaning position of the equipment; and

FIGS. **3** and **4** depict a filter box or housing of a second exemplary embodiment of the invention in the operating positions corresponding to the showing of FIGS. **1** and **2** respectively.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, in the exemplary embodiment of equipment depicted in FIGS. **1** and **2**, reference numeral **10** designates a filter housing or box which forms a part of a not further illustrated suction installation of a textile machine. This filter housing is coupled via a tubular conduit **12** with the suction nozzles are openings at such textile machine. The tubular conduit or pipe **12** opens into a raw air compartment or chamber **14** provided within the filter housing **10.** Furthermore, a suction conduit **16** communicates with the raw air compartment **14,** and this suction conduit

16, for instance together with a number of corresponding suction lines or conduits, is associated with a central fiber depository. The further suction conduits or lines are likewise operatively coupled with a respective filter housing of a suction installation, each suction installation servicing a further textile machine or a further group of textile machines.

Now the raw air compartment **14** communicates with a clean air compartment **20** through the agency of an air filter **18,** and the clean air compartment **20** is located at the suction side of a blower or ventilator **22.** This blower or ventilator **22** is continuously driven by an electric motor **24** and communicates at its pressure side with an exhaust air chute or shaft **26** within the filter housing **10.** An outlet opening **28** at the filter housing connects the exhaust air shaft **26** with the atmosphere. A wall and deflecting element **30, 32** which limits the exhaust air shaft **26** with respect to the air filter **18** and the clean air compartment **20** contains an opening **36** which can be closed by suitable closure means, here shown as a flap member **34.** This flap member **34** is closed in the work position of the filter housing, as same has been depicted in FIG. **1.** Furthermore, the clean air compartment **20** contains closure means, in the form of the shut-off flap member or valve **38,** the center of rotation of which has been indicated by reference character **40,** and which possesses a curved configuration in light of flow considerations. Finally, in the raw air compartment **14** at the region of the conduits **12** and **16,** there is arranged a flamp member **42,** the axis or point of rotation of which is located at the hinge location **44,** and possesses two flap portions **46** and **48** which are arranged perpendicular to one another. In the work position of the filter housing depicted in FIG. **1,** the flap member or flap **42** assumes a position where it shuts-off the suction conduit or line **16** with respect to the raw air compartment **14.** On the other hand, the flap member **38,** in the work position depicted in FIG. **1,** is located in its open position, as shown.

As indicated by the arrows depicted in FIG. **1** and which designate the flow direction of the air, the air sucked-up by the blower **22** enters via the conduit **12** into the raw air compartment **14,** flows through the filter **18** from its upstream side to its downstream side and thereafter through the clean air compartment **20,** in order to be finally ejected into the atmosphere via the exhaust air shaft **26.** During passage through the filter **18,** the sucked-up air is freed of its foreign particles or contaminants, such as fibers and dust, which then deposit upon the raw air side of the filter **18** and at that location gradually form a layer or covering.

The equipment has preferably associated therewith a control which, either as a function of time or as a function of the pressure differential between the raw air compartment **14** and the clean air compartment **20,** triggers the cleaning operation. This control can also be part of the central suction installation and insures that all of the filters and filter housings will be cleaned in a predetermined sequence.

Cleaning of the filter **18** is initiated in that, on the one hand, the flap member **34** is rocked out of the closed position depicted in FIG. **1** into the position depicted in FIG. **2** where it frees the opening **36** and, on the other hand, interrupts the connection between the pressure side of the blower and the opening **28** in the shaft **26.** At the same time and likewise in a sudden or surge like manner, the flap member or flap **38** is rocked out of the position depicted in FIG. **1** into the position depicted in FIG. **2** in which such subdivides the clean air compartment **20** into two components and specifically in such a way that the connection between the filter **18** and the suction side of the blower **22** is interrupted. In the closed position, the flap member **38** cooperates with an inner boundary **50** of the filter housing which is designed so as to be favorable to the flow, and moreover the flap member **38** bears against the deflecting body **32.** Preferably simultaneously with the reversal of the flap members **34** and **38,** there also occurs a reversing or switch-over of the flap member **42** out of the position depicted in FIG. **1** into the position depicted in FIG. **2.** As a result, due to the flap portion **46** there is interrupted the connection between the conduit **12** and the raw air compartment **14,** whereas the flap portion **48** frees the connection between the raw air compartment **14** and the suction conduit **16.** In the position of the flap member or flap **42** depicted in FIG. **2,** its shorter flap portion **48** provides a throughflow or passage **52** which by-passes the conduit **12** with respect to the suction conduit **16;** the suction operation at the textile machine, for this flap position, is assumed by the central suction installation via the suction conduit or line **16.**

The sudden reversing or shifting of the flap member **34** out of the position of FIG. **1** into the position of FIG. **2** produces the result that the air, which has already passed through the filter **18** into the clean air compartment and moves through the blower, will be deflected at the flap member **34** and will flow along a bypass path of travel through the opening **36** as a shock wave against the filter **18** and impinges thereagainst from the clean air side i.e. downstream side thereof. Within the clean air compartment **20** the shock wave can only expand to a limited extend since at the same time as there is a shifting or reversing of the flap member **34** the flap member **38** will be shifted or rocked into the closed position. Since a negative pressure has prevailed in the clean air compartment prior to reversing the position of the flap member **34,** and after such positional reversal, the pressure side of the blower communicates with the filter, the shock wave attains a considerable intensity which in any event is sufficient to practically completely free the filter of its contaminants of foreign particles. These contaminants are entrained together with the shock wave into the suction conduit **16.** On the other hand, flap member **42** prevents the shock wave from also having an effect within the conduit **12.**

Actuation of the flaps or flap members **34, 38, 42** as well as, if desired, a further flap member **54** occurs in the illustrated exemplarly embodiment by means of the schematically depicted servomotor **100** in the form for instance of a cylinder and piston arrangement, wherein as the actuation medium there can be used compressed air. The piston is thus connected with the individual flaps via non-illustrated rods, merely schematically represented by the broken connection lines. Servo controls which can be used with the various embodiments of the invention herein disclosed are well known in the art so that no further consideration thereof need be given, particularly since the details thereof are not part of the invention nor are such necessary for understanding the concepts thereof.

While the air, which is completely removed from the clean air compartment, and serving to form the shock wave, is sufficient for cleaning the filter **18,** it can be

advantageous for other reasons to support, during a brief period of time, a flow through the raw air compartment in the direction of the suction conduit or line **16** through the blower or ventilator **22.** To this end, the flap member **54** can free an opening **56** which communicates the suction side of the blower **22** with the atmosphere.

Although the flap member **38** for the cleaning of the filter **18** is not necessary under all cicumstances, it has been found to be extremely advantageous for a universally employed suction installation and the associated filter housings. In many situations, the flap member must not be completely closed upon initiating the cleaning operation, since it does not have any significance for the generation of the shock wave and only limits its propagation. Therefore it can be advantageous to adjustably limit the path through which the flap member **38** can move in the closing direction. As a result, the effectiveness of the shock wave at the filter **18** can be accommodated to the conditions prevailing at the suction installation and especially to the fiber material which is being processed by the textile machine.

Instead of using the flap member **42,** there can also be provided shut-off means for the conduits **12** and **16** in such a manner that during a first phase of the cleaning operation the suction conduit **16** is shut-off with respect to the raw air compartment and only communicates with the conduit **12.** During a second phase of the cleaning operation, the raw air compartment could thereafter be connected with the suction conduit **16** for the withdrawal of the fibers which have been detached from the filter **18.** Suitable as the shut-off means, which also would be capable of shutting-off the suction conduit **16** with respect to the raw air compartment during normal operation of the filter housing and to connect the conduit **12** with the raw air compartment, there could be employed for instance two independently actuatable flaps or flap members which would be pivotable about the pivot point **44.** The flap member corresponding to the flap portion **48** would then only have the function of controlling the entry into the suction conduit **16** from the raw air compartment **14,** whereas the flap member corresponding to the flap portion **46,** in its one position, would shutoff the passage **52,** whereas in the other position the connection between the conduit **12** and the raw air compartment **14** would be interrupted. By this arrangement, the shock wave may be prevented from propagating through the suction conduit or line **16.** In the event that the occurring shock wave is too intense for cleaning the filter **18,** then such can be accommodated to the conditions which prevail in the individual case in that the flap member **34** would not completely interrupt the connection between the pressure side of the blower **22** and the shaft **26.** A part of the air conveyed by the blower therefore can escape into the shaft **26.**

For the removal of the contaminants out of the raw air compartment **14,** it basically does not require any negative pressure in the conduit **16.** The transport air current in the conduit **16,** with appropriate design of the equipment, can also be formed by a negative pressure flow which is produced by the blower **22.** Maintaining such transport air current throughout a predetermined duration, which is sufficient for moving through the transport path, is facilitated by sucking-up ambient air through the opening **56.**

Instead of having the contaminants delivered to a central fiber depository, such could also be conducted to a deposit location neighboring the filter housing, and which is then periodically emptied. Here also emptying can occur pneumatically or, if desired, also manually. According to a particularly advantageous construction of the filter housing, such itself contains a deposit space or area which is formed by a dead-flow zone of the raw air compartment, or, however, the raw air compartment communicates via an opening which can be closed by a flap with a deposit compartment. In so doing, opening of the flap can occur, for instance, due to the excess pressure which prevails during the cleaning phase, against the action of a closing spring, provided that actuation thereof is not controlled by a suitable mechanism.

If, as previously mentioned, there is dispensed with a negative pressure flow in the conduit **16** and the withdrawal or removal of the contaminants out of the raw air compartment **14** is brought about by the excess pressure flow generated by the blower **22,** then the suction operation at the therewith connected textile machine can also be maintained during the cleaning phase in that a suction air current is generated in the conduit **12** by means of an injector action. To this end, the outlet opening of the raw air compartment in the conduit **16** can be assigned as an injector nozzle and there can be produced between the conduit **12** and the conduit **16** a tubular connection which surrounds the raw air compartment **14.** At the mouth, located at the region of the injector nozzle, of the bypass-tubular conduit, there then prevails in the conduit **16** in known manner a negative pressure when the air conveyed from the blower **22** into the injector nozzle escapes at an increased velocity into the conduit **16.**

In FIGS. **3** and **4** there is illustrated a further embodiment of the inventive filter housing or box. The components of this embodiment which are the same as the embodiment of FIGS. **1** and **2** have employed therewith the same reference character, however in conjunction with a "prime" (') marking.

The filter housing or box **10'** contains, apart from the filter **18',** an auxiliary filter **19,** which together with the first filter is located in a common plane and is separated therefrom by a pivot mounting **65** of a pair of flaps **67,** 69. The filter surface of the filter **18'** is preferably larger than that of the auxiliary filter **19.** The filter **18'** which is situated closer to the flap or flap member **48',** during normal operation is impinged by air, whereas the auxiliary filter **19** which is situated closer to the conduit **12'** is impinged by air during cleaning of the filter housing. The flap **67** provides a connection between the conduit **12'** and the filters **18'** and **19'** respectively which are to be impinged. The flap or flap member **69** provides the connection between the filters **18'** and **19** respectively and the blower or ventilator **22'.** As will be seen by referring to FIG. **3,** during normal filter operation the flaps or flap members **67, 69** and **34'** are positioned in such a manner that the conduit **12'** is in flow communication via the filter **18'** and the blower **22'** with the exhaust air shaft **26';** the flap member **48'** is closed. The fibers contained in the raw air and the dust deposit upon the impinged face or side of the filter **18'.**

For cleaning of the filter housing or box and especially the filter **18'** all of the flap members are shifted into the position depicted in FIG. **4.** By means of the

flap members **67, 69,** the raw air is then guided from the conduit **12'** through the auxiliary filter **19** and conducted into a cleaned state to the blower **22'**.

Since the positional shifting or reversing of the flap member **34'** occurs suddenly, whereby the exhaust air shaft **26'** is closed, the air conveyed by the blower **22'** impinges against the clean air side of the filter **18'** in the form of a shock wave. The contaminants which have collected upon the raw air side of such filter are detached from the filter by the energy removed from the working air current and such detached contaminants are delivered to the conduit **16'**.

Since no negative pressure prevails in the conduit **16'**, the flap member **48'** can be opened by the shock wave against the action of a closure spring. The excess pressure flow, maintained by the blower **22'**, retains the flap member **48'** open as long as the flap members **67,** 69 and **34'** assume the position depicted in FIG. **4.**

Of considerable importance for this exemplary embodiment is the fact that during the cleaning phase of the filter, the operation of the suction installation at the textile machine and which is coupled via the conduit **12'** not only need not be interrupted but rather also that the air which is sucked-off during this phase can be employed for the withdrawal or removal of the fibers through the conduit **16'**. Therefore, there can be dispensed with the sucking-up of the ambient air and therefore an opening controlled by a flap member similar to the flap member **54** and the opening **56** of the embodiment of FIGS. **1** and **2.**

Cleaning of the auxiliary filter **19** can occur manually at periodic intervals, wherein it should be noted however that the amount of fibers and dust which collects at such filter is relatively slight, corresponding to the relatively brief cleaning phases.

Both for the embodiments of FIGS. **1** and **2** as well as also for those of FIGS. **3** and **4,** the outflowing air which moves through the exhaust air shaft **26** and **26'** respectively can be delivered to an air conditioning installation which serves to climatize or air condition the room containing the textile machines.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

Accordingly, what is claimed is:

1. A method for automatically cleaning an air filter, comprising the steps of guiding a working air current containing contaminants in a predetermined direction of travel through the air filter from an upstream side to a downstream side thereof, suddenly deflecting a part of the working air current which has passed the downstream side of the filter to impinge the filter in the form of a shock wave at the downstream side of said filter, partially shutting off the working air current flowing on the downstream side of the filter and traveling in said predetermined direction, and deriving the energy of the shock wave from the working air current due to the sudden deflection of the part of the working air current.

2. The method as defined in claim **1,** wherein the step of suddenly deflecting a part of the working air current includes the step of directing the part of working air current along a direction of travel differing from said predetermined direction of travel and in a direction toward the downstream side of the air filter.

3. An apparatus for automatically cleaning an air filter, comprising a filter housing, an air filter within the filter housing dividing said filter housing into a raw air compartment and a clean air compartment, an inlet opening communicating with the raw air compartment, a blower having a suction side and a pressure side, the suction side of the blower being in flow communication with the clean air compartment, deflecting means mounted for movement between two positions, said deflecting means in one position communicating the pressure side of the blower with the atmosphere, said deflecting means in the other position communicating the pressure side of the blower with the clean air compartment and providing a bypass flow path from the pressure side of the blower to the clean air compartment during cleaning of the filter, means for at least partially shutting-off the suction side of the blower with respect to at least a portion of the clean air compartment, and means for simultaneously actuating the shut-off means together with the deflecting means.

4. The apparatus as defined in claim **3,** including an exhaust shaft connected to the pressure side of the blower and wherein said deflecting means in said one position communicating the flow from the pressure side of the blower with atmospheric via the exhaust shaft and said deflecting means in said other position closing off the pressure side of the blower with respect to the exhaust shaft and terminating the flow through said exhaust shaft.

5. The apparatus as defined in claim **3,** wherein the shut-off means comprises a flap member arranged in the clean air compartment and adapted to be actuated to a filter cleaning position in which the clean air compartment is subdivided into two parts, wherein a first part of such clean air compartment is connected with the suction side of the blower and the second part thereof is connected via an opening with the pressure side of the blower, said opening being controlled by the deflecting means.

6. The apparatus as defined in claim **5,** further including an auxiliary filter having a clean air side and a raw air side, said clean air side of the auxiliary filter communicating with the first part of the clean air compartment, and means operatively associated with the raw air side of the auxiliary filter for communicating the flow of said inlet opening to said auxiliary filter.

7. The apparatus as defined in claim **6,** wherein the operatively associated means is adapted to be actuated to a position in which the flow of said inlet opening to said auxiliary filter is shut off.

8. The apparatus as defined in claim **3,** further including a suction conduit connected with the raw air compartment, and means for at least partially shutting-off the inlet opening from the raw air compartment and simultaneously communicating the inlet opening with the suction conduit.

9. The apparatus as defined in claim **3,** wherein the clean air compartment, at the suction side of the blower, possesses a closable air inlet opening.

10. An apparatus for automatically cleaning an air filter, comprising a filter housing, an air filter within the filter housing dividing said filter housing into a raw air compartment and a clean air compartment, an inlet opening communicating with the raw air compartment, a blower having a suction side and a pressure side, the suction side of the blower being in flow communication with the clean air compartment, deflecting means

mounted for movement between two positions, said deflecting means in one position communicating the pressure side of the blower with the atmosphere, said deflecting means in the other position communicating the pressure side of the blower with the clean air compartment and providing a by-pass flow path from the pressure side of the blower to the clean air compartment during cleaning of the filter, and means for at least partially shutting-off the suction side of the blower with respect to at least a portion of the clean air compartment.

11. The apparatus as defined in claim **10,** including an exhaust shaft connected to the pressure side of the blower and wherein said defelecting means in said one position communicating the flow from the pressure side of the blower with atmosphere via the exhaust shaft and said deflecting means in said other position closing off the pressure side of the blower with respect to the exhaust shaft and terminating the flow through said exhaust shaft.

12. An apparatus for automatically cleaning an air filter, comprising a filter housing, an air filter having an upstream side and a downstream side with respect to a predetermined direction of travel of air through said air filter, said air filter being arranged within the filter housing and dividing the filter housing into a raw air compartment on the upstream side of the air filter and a clean air compartment on the downstream side of the air filter, an inlet opening communicating with the raw air compartment, an outlet opening communicating with the clean air compartment, means for forcing air to flow in said predetermined path of travel successively from the inlet opening through the raw air compartment and clean air compartment to the outlet opening, means for suddenly deflecting at least part of the air moving from said clean air compartment in the direction of the outlet opening in order to move said air along a by-pass of travel which differs from said predetermined path of travel and in a direction towards the downstream side of the filter and means for at least partially shutting off a portion of the clean air compartment from the downstream side of the filter.

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