

Clean Room Ceiling Filter Unit Support System

Background of the Invention

1. Field of the Invention

This invention relates to clean room systems and, in particular, clean room ceiling systems. "Ceiling" herein includes not only horizontal upper walls and lower walls or floors of rooms but also vertical side walls. The terms lower, upper, above, below, and the like and their cognitives have reference to a conventional ceiling installation and are to be understood as relative terms when the "ceiling" is other than above the workspace.

2. Related Art

Clean room ceilings are known and typically comprise one or more filter units supported by a structure that is separate or integral with the filter units. Facile installation and removal of the filter units, which are replaced from time-to-time, is of increasing importance. Replacement from the room side of the filter system is desirable for increased convenience and lower cost. The need to air-tightly mount the filter units in their filter support structure has lead to the use of supports that have flanges or lips against which the filter units rest in sealed condition. Passing the flanges to insert filter units can be problematic. More recently, it has been demonstrated that sealing tape can be used at the interstices of the filter arrays to block unfiltered air flow, eliminating in some systems the use of support flanges, and easing the insertion problem.

Summary of the Invention

According to a first aspect of the present invention, there is provided a clean room ceiling filter unit support system for a filter unit to be suspended adjacent a workshop, the filter unit comprising a peripheral frame and filter media sealed within said frame, and a filter unit support adjacent said frame for supporting said filter unit adjacent said workspace, said filter unit support system comprising cooperating fasteners carried by said peripheral frame of said filter unit and said filter unit support in which one cooperating fastener is deflectable in pivoting relation by its said cooperating fastener and being biased against said deflection to return to an undetected position to support said filter unit in said filter unit support after deflection.

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According to a second aspect of the present invention, there is provided a clean room filter comprising a filter unit for mounting in a support supported by a support surface, said filter unit having outwardly facing side walls of a peripheral frame and filter media sealed with said peripheral frame, said side walls and support defining self-deflecting cooperating fasteners adapted to support said filter unit at said support and spaced from said support surface.

Example embodiments may relate to filter units comprising a frame and filter media sealed in the frame, support structure comprising a support such as a grid or other array of support elements, or a filter unit receiver of one or more interconnected modular bays congruent and close-fitting with the filter units, and cooperating fasteners including plural spring-loaded latch and keeper fasteners for separably attaching the filter units into the support structure with a simple push-in, pull-out movement.

Mounting the filter units in their support structure directly, easily and without tilting may be desirable, and can now be achieved with a filter unit mounting system that reacts to the presence of the filter. Desirably such a system may also permit the separation of the filter unit from the support readily and from the room side.

Brief Description of the Drawings

The invention will be further described in conjunction with the attached drawings in which:

Fig. 1 is an oblique view of the invention, clean room ceiling with the filter separated to show the fasteners;

Fig. 2 is an exploded view of the invention filter unit and receiving unit support structure.

Fig. 3A is a fragmentary detail view in elevation of the filter unit side with attached pivoting latch in pin engagement;

Fig. 3B is a view like Fig. 3A with the attached pivoting latch pivoted away from the pin;

Fig. 3C is a fragmentary detail view in elevation of the filter unit and the support structure, the latches on each side being tethered together with a common tether;

Fig. 4 is a bottom plan view of the filter unit and support in assembled condition as typically viewed from the workspace;

Fig. 5A is a side elevation view, partly in section, of the filter unit equipped with a damper and damper adjustment features;

Fig. 5B is a fragmentary, detail view of the filter unit damper and damper adjustment features; and,

Fig. 6 is a side elevation view, partly in section, of the filter unit being used to introduce test material into the air flow.

Description of the Preferred Embodiments

With reference now to the drawings in detail, in Figs. 1 and 5A a first illustrative embodiment of the invention has the invention clean room ceiling system generally indicated at 10. The system 10 comprises a dropped ceiling 12 of horizontally disposed and laterally and longitudinally extended filter unit support 14 including support structures 30 carried at the lower ends 15 of vertically disposed hangers 16 that are attached at their opposite upper ends 17 to the room true ceiling 18. Any other suitable form of vertical or horizontal support can be used. The filter unit support structures 30 are arranged to overlie the closed space room 22 and the workspace W therein. The function of the ceiling system 10 is to introduce HEPA or UPLA standard air or other highly filtered air to workspace W, the air being typically received for filtering from an air supply 24 indicated by flexible conduit 26 (Fig. 5).

The clean room ceiling system 10 further includes one or a plurality of filter units 28 that have a predetermined shape, here shown as rectangular, and that comprise a frame 32 and filter media 34 sealed within the frame. The filter unit support structures 30 are congruent with and closely fit with the adjacent the filter unit frames 32 so as to support the filter units 28 to one side of the workspace W.

In one aspect the invention provides a rapid-acting, secure, and easily reversed, superior form of mounting attachment of the filter units 28 to the filter unit support 14. As particularly shown in Figs. 1-4, the filter unit support 14 includes individual or grid-arranged support structures 30 typically comprising a housing or receiver 36 that defines a receptacle or a series of receptacles 38 for receiving and mounting the individual filter units 28, plural sets of paired cooperating latch and keeper fasteners 42 carried by the filter unit frame 32 and the filter unit support receivers 36. The fasteners 42 comprise opposed (and in registerable relation) pairings 44, 46, 48, 52 to function as an assembly of a latch 54 and a pin 56.

With reference to Figs. 3A, 3B and 3C, each latch 54 (shown closed in Fig. 3C), has a leading shoulder 58 by which the latch is deflectable in pivoting relation on pivot 62. Pivoting is caused by cooperating keeper 64 shown in the form of pin 56. Upon engagement of the keeper pin 56 with the latch leading shoulder 58, the latch pivots so as to pass the keeper pin (see Figs. 2, 3A and 3C). Tension spring 66 biases each latch 54 against the keeper pin 56-caused deflection. Tension spring 66 is coupled between latch portion 68 and the filter unit frame 32 so as to be adjacent to and offset from the pivot locus 62. Thusly mounted, the spring 66 tends to keep the latch engaged with cooperating keeper pin 56. Each latch 54 by virtue of its mounting and spring-loading as described is adapted to return to an undeflected position (Figs. 2, 3A) in keeper pin 56-engaged relation to block separation of the filter unit 28 from the filter unit support receiver 36 after the latch passes the keeper pin.

The latch 54 further has a trailing shoulder structure indicated at 74 by which the latch is reversely deflectable to disengage from the keeper pin 56. Preferably reverse deflection is effected from outside the filter unit support receiver 36 as hereinafter set forth. The reverse deflection of the latch 54, suitably from within the workspace W, releases the filter unit 28 from the filter unit support receiver 36 and permits lowering of the filter units 28 from the support receivers 36.

In the embodiment shown in Figs. 1-4, the filter unit frame 32 defines four outward facing sides 76, 78, 82 and 84. Preferably two, but as many as four of the sides 76 - 84 carry one or more latches 54 (or keeper pins 56) each in latching relation with a mating keeper (or latch) respectively carried by the filter unit support receiver 36.

5 A filter unit support receiver 36 is disposed circumjacent to each filter unit frame 32. Each receiver 36 has four inward facing sides 86, 88, 92, 94 corresponding to the four outward facing sides 76 - 84 of the filter unit 28, the inward facing sides being arranged to be opposite each of the respective filter unit outwardly facing (latch 54 or keeper pin 56-carrying) sides. Thus, at least two but as many as four the filter unit support receiver

10 inward facing sides 86 - 94 carry one or more keeper pins 36 (or latches 54) in latching relation with a latch (or keeper) carried by the filter unit receiver outward facing sides 76 - 84 in latch registerable relation.

Preferably, oppositely facing, longer sides 76, 78 of the filter unit frame 32 each carry a pair or set of spring-loaded latches 54. The keeper pins 56 project into the

15 receiver interior 37 and extend normal to the receiver inward facing sides 86, 88 to oppose the latch shoulders 58. Each latch 54 is mounted (at pivot 62) to its respective outward facing side so as to pivot in a plane parallel to the filter unit side (76, 78) carrying the latch. Latch leading shoulder 58 contacts the opposing keeper pin 56 at a point on the shoulder 58 that will deflect the shoulder away from the pin 56, and cause

20 the latch to pivot.

Each latch 54 is preferably hook-shaped, having a body portion 96 that is pivoted at pivot 62, an arm portion 98 extending from the body portion. Arm portion 98 defines the latch leading shoulder 58. Arm portion 98 is spaced from the latch body portion 96 a small distance so as to define a keeper pin 56-receiving slot 104 that travels arcuately

25 upon rotating deflection of the latch 54. Arm portion 98 in a deflected orientation or condition is arranged and sized to pass the keeper pin 56, and to engage the keeper pin 56 by receiving the pin in slot 104 in the non-deflected orientation or condition of the latch 54 and its arm portion, as shown in Fig. 3A.

Arm leading shoulder 58 has a cam-shape, as shown, with its axis of revolution

30 offset from the pivot 62, or any other shape that will rotatably drive the latch 54 about its pivot locus when the shoulder is engaged with the keeper pin 56. The curvature of leading shoulder 58 is such that contact of the leading shoulder with the keeper pin 56

tips the latch in a manner to position the slot mouth 106 for entry of the keeper pin 56 into slot 104.

Each of the filter unit sides 76 – 84 has a front face 108 that extends normal to the sides and faces the workspace W. Each latch 54 preferably has, in the illustrated embodiment, a flange 110 extending at a right angle from the trailing shoulder 74 of latch body portion 96. Flange 110 separably engages the side front face 108 and serves to block overrotation of the latch 54 under the biasing force of spring 66, and as well provides a finger hold for rotating the latch from within the workspace W.

For purposes of facilitating the reverse rotation together of each latch 54 to disengage the latches from keeper pins 56, the latches are preferably connected with a link bar or cable shown as tether 112. Tethers 112 are suitably secured to latch portion 68 and are of a length and arrangement suitable for simultaneously pivoting two or more of the latches 54 in a set from their pin 56 engagement. The tether 112 is actuated by rotation of one of the coupled latches 54 by its flange 110 accessible from within the workspace W so that the reversal of the filter unit 28 latching is readily effected by pulling the room-exposed flange 110 on one of the latches and thereby simultaneously shifting from pin 56 engagement the other latch or latches coupled by the tether 112 to the one latch.

In the arrangement shown, the separate latches in each set or pair of latches 541, 542 on each filter unit frame side, e.g. 76, 78 are connected together by a common tether 112. Alternatively, all latches in a given set of latches for a filter unit 28 or a receiver 36 can be connected with a single tether 112. In each arrangement, it is desirable to provide for sufficient simultaneity of latch actuation by tether 112 that the filter unit 28 is smoothly and predictably released from its receiver 36. The coupling of several latches 54 with a common tether 112 enables a single worker to release and control the filter unit 28 in removing it from the receiver 36 and thus provides a more economical arrangement than systems requiring two or more workers to handle the filter unit removal.

In summary, the present embodiment filter unit frame 32 is rectangular and has first and second pairs of outwardly facing sides 76, 78 having respectively first and second sets of pivoting latches 541, 542 mounted thereon in longitudinally distributed relation along the long axis of the sides. The filter unit support 14 includes first and

second sets of keeper pins 561, 562 also longitudinally distributed and mounted in cooperating relation with the first and second sets of latches 541, 542. First and second tethers 1121, 1122 separately connect the first and second sets of latches 541, 542 respectively for pivoting together latches 541 or 542 within each set in pin 56 separating
5 relation.

The filter unit support structure sides 86, 88, 92 and 94 each have an external U-shaped flange 116 comprising a stub wall 118 extending parallel to the structure side and spaced therefrom across a narrow gap 122. The support structures may also include an internal flange 123 having a knife edge 125 (Fig. 3C) for sealing purposes as
10 explained below. The keeper pin 56 is supported in place by the structure side e.g. 86 and suitably also by the stub wall 118 in gap 122 traversing relation.

The filter unit sides 76, 78, 82 and 84 also have an external U-shaped flange 124 that is perimetrically sized to fit within the filter unit support receiver 36 and shaped as shown to receive the support structure internal flange 123. The flange 124 contains a
15 fluid or solid sealant 127 that is suitably known per se such as a neoprene or other material sealing gasket or a sealing gel for sealing the filter unit 28 to the receiver 36 as the flange knife-edge 125 seals against the sealant. Or the sealing of these parts may be by a sealing bead or tape at their locus of abutment. See, for example USP 5,871,556 to Jeanseau and Braman, the disclosure of which is incorporated herein by
20 this reference.

Filter unit flange 124 also supports the latch sets 541, 542 by supporting the pivot pin 62 on which the latch bodies 96 rotate. The invention thus provides a unique filter unit 28 for use in clean room ceiling systems comprising a filter unit 28 for mounting in a support 30 supported by a support surface 18. The filter unit has a frame
25 32 with outwardly facing side walls 76 - 84 and filter media 34 permanently or replaceably sealed within the frame. The filter unit side walls 76, 78 support cooperating fasteners comprising latches 54 and keeper pins 56 that are adapted to support the filter unit 28 at the support 30 and spaced from the support surface 18.

In this aspect, the invention method includes maintaining the filter unit 28 and
30 filter unit support structure 30 in air filtering relation to workspace W within clean room 22, coupling the filter unit to the support structure with cooperating latch 54 and keeper pin 56 by deflection of the latch upon contact with the keeper to pass the keeper, the latch being adapted to latch onto the keeper once past the keeper in filter unit

supporting relation on the support structure, and reversely deflecting the latch 54 by actuating flange 110 and simultaneously deflecting adjacent and coupled latches sharing the tether 112 to disengage the filter unit from the support structure.

5 With reference now to Figs. 5A, 5B and 6, the invention also provides an apparatus for and method of testing high efficiency particulate air filtering media in a filter unit mounted in a clean room including introducing a test material into a rod at a rod inlet at the down stream side of the media, and releasing the test material onto the upstream side of the media at a rod outlet, while passing air from the upstream side to the downstream side of the media.

10 In this embodiment, with reference to Figs, 5A and 5B, the filter units 28 and supports 30 are much like those previously described, modified as follows: The filter units 28 are typically separate units but can be in an array where the receiver 36 is one of several in a grid pattern as shown in Fig. 1. The filter units 28 have multiple filter media packs 34a, 34b that are separated by a divider 114 and sealed into the frame 32.

15 A bracket 115 surmounts the divider 114 and carries a bushing 158. The filter unit 28 further includes an upper cover 132 fixed to the frame sides 76 - 84. The upper cover 132 has a central opening 134 surrounded by a collar 136. The pressurized air supply 24 to the filter unit 28 communicates with air inlet 142 formed by the outlet 144 of flexible conduit 146. The conduit opening 148 registers with the inlet collar 136 and is

20 secured thereto in fluid tight relation.

A damper 152 comprising a perforated plate 154 controls the inflow of air from conduit 146. A vertically or axially shiftable rod 156 extends within a tube 155 that is fixed within divider 114. O-rings 157 seal the rod 156 in the tube 155. Rod 156 is journaled and supported by bushing 158 fixed to the bracket 115. Rod 156 carries the

25 damper plate 154 and extends within the tube 155 in the divider 114 from the workspace W to the air inlet 142. Suitably, rod 156 is threaded to threadedly advance through threaded bushing 158 supported above the plane 157 of the filter media 34a, 34b for adjusting vertically with reference to the fixed bushing by rotation with a screwdriver or other tool acting on the workspace W-exposed lower end 162 of the rod.

30 Damper 152 is thus shifted more or less to collar 136 by adjustment of the rod 156 in bushing 158 to increase or decrease air flow to the filter unit 28 as needed to balance the air flow across the filter unit or among plural filter units in an array. The ability to adjust the damper 152 setting from within the workspace W is a signal

advantage of this embodiment of the invention. A further feature is the integration of the damper 152 and the rod 156 into the filter unit 28 so that each replacement filter unit brings the entire assembly for convenience and lower cost.

In a further embodiment, shown specifically in Fig. 6, rod 156 is made tubular. A
5 test material 164 such as an aerosol challenge mist of appropriately sized particles for testing a HEPA or ULPA filter efficiency is injected from supply 166 or otherwise expressed into the rod 156 from below the filter media 34a, 34b for delivery into the pre-filter media airstream upstream of and on top of the filter media in the filter unit 28 from within the workspace W. Material 164 passing through the media 34 is measured to test
10 the filter unit 28. This ability to conduct testing without having an operator go above the filter units is an important advantage of this embodiment of the invention.

I claim:

1. A clean room ceiling filter unit support system for a filter unit to be suspended adjacent a workspace, the filter unit comprising a peripheral frame and filter media sealed within said frame, and a filter unit support adjacent said frame for supporting said filter unit adjacent said workspace, said filter unit support system comprising cooperating fasteners carried by said peripheral frame of said filter unit and said filter unit support in which one cooperating fastener is deflectable in pivoting relation by its said cooperating fastener and being biased against said deflection to return to an undetected position to support said filter unit in said filter unit support after deflection.
2. The clean room ceiling filter unit support system according to claim 1, in which said one cooperating fastener is spring-loaded and mounted for pivoting movement.
3. The clean room ceiling filter unit support system according to claim 1, in which said one cooperating fastener is reversely deflectable from outside said filter unit support system to disengage from said support system.
4. The clean room ceiling filter unit support system according to claim 1, in which said filter unit has a plurality of outward facing sides, at least two of said sides carrying a cooperating fastener.
5. The clean room ceiling filter unit support system according to claim 4, in which at least two of said filter unit frame outward facing sides carry said one cooperating fastener, said one cooperating fastener comprising a spring-loaded latch, said latch including a latch shoulder, said latch pivoting in a plane parallel to said filter unit side carrying said latch, said inward facing support sides each carrying a second cooperating fastener opposite each said latch comprising a keeper having a pin projecting normal to said filter unit support and arranged to engage said latch shoulder in deflecting relation, said latch being hook-shaped to capture said pin following said latch shoulder passing said pin in filter unit supporting relation on said pin,
6. The clean room ceiling filter unit support system according to claim 5, in which said filter unit sides carrying said latches have a front face normal to said sides, each said latch having a second trailing shoulder having a flange arranged to separably engage said side front face in the latched condition of said filter unit in said filter unit support.
7. The clean room ceiling filter unit support system according to claim 6, including also a tether secured to each said latch for simultaneously pivoting multiple

ones of said latches from pin engagement by said tether pivoting one said latch, said tether being accessible from within a clean room.

8. The clean room ceiling filter unit support system according to claim 7, in which sets of said latch structures are tethered by a common tether for simultaneous
5 pivoting from pin engagement by said tether.

9. The clean room ceiling filter unit support system according to claim 8, in which said filter unit frame is rectangular and has first and second pairs of outwardly facing sides, said first and second pairs of sides having respectively first and second sets of pivoting latches mounted thereon in longitudinally distributed relation, said filter
10 unit support having first and second sets of pins mounted thereon in cooperating relation with said first and second sets of latches, first and second tethers separately connecting the members of said first and second sets of latches respectively for pivoting together each of the latches within each set in pin separating relation responsive to the pivoting of one latch within the set.

10. The clean room ceiling filter unit support system according to claim 8, in which said filter unit support structure sides have an external U-shaped flange comprising a stub wall extending parallel to said structure side and spaced therefrom across a gap, said pin being supported in place by said structure side to project into the interior of said support structure.

11. The clean room ceiling filter unit support system according to claim 10, in which said filter unit supported latch comprises a latch member pivoted on said filter unit side, said latch member comprising a blade defining at one end a latch leading shoulder and at the other end a flange defining a latch trailing shoulder, and defining a pivot locus between said ends, said latch member blade engaging said pin within said
25 support structure interior.

12. The clean room ceiling filter unit support system according to claim 11, in which said filter unit sides have a U-shaped flange opposing said support structure interior, said filter unit side flanges carrying said latches in pin registered relation.

13. The clean room ceiling filter unit support system according to claim 11, including also a tether connected between adjacent latches for pivoting said latches
30 together from pin engagement, sets of latches being tethered to a common tether for simultaneous pivoting from pin engagement of each member of a set of latches upon pivoting of any member of the set.

14. A clean room filter comprising a filter unit for mounting in a support supported by a support surface, said filter unit having outwardly facing side walls of a peripheral frame and filter media sealed with said peripheral frame, said side walls and support defining self-deflecting cooperating fasteners adapted to support said filter unit at said support and spaced from said support surface.

15. The clean room filter according to claim 14, in which one said cooperating fastener is a generally hook-shaped latch that is adapted to cooperate with a keeper comprising a pin projecting normal to said filter unit, said latch being constructed and arranged such that its leading shoulder engages said pin in deflecting relation and captures said pin following said latch leading shoulder passing said pin in filter unit supporting relation on said pin.