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AIR FILTER APPARATUS

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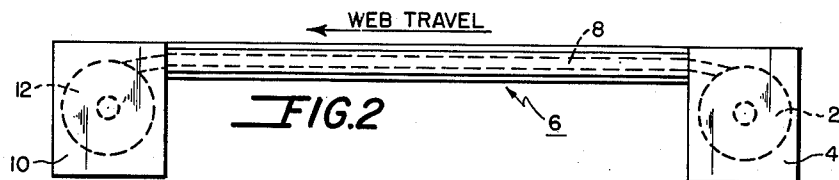
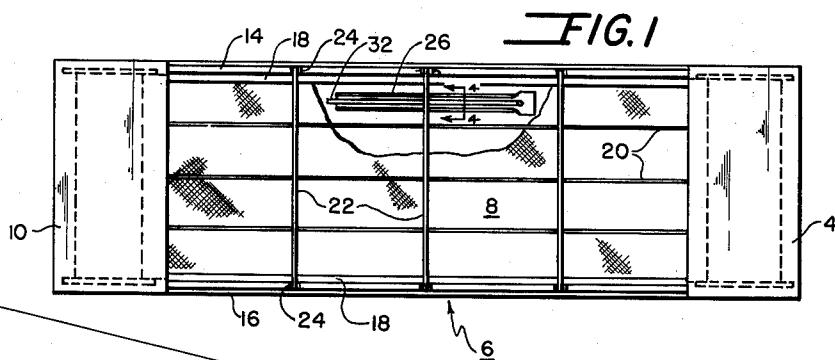
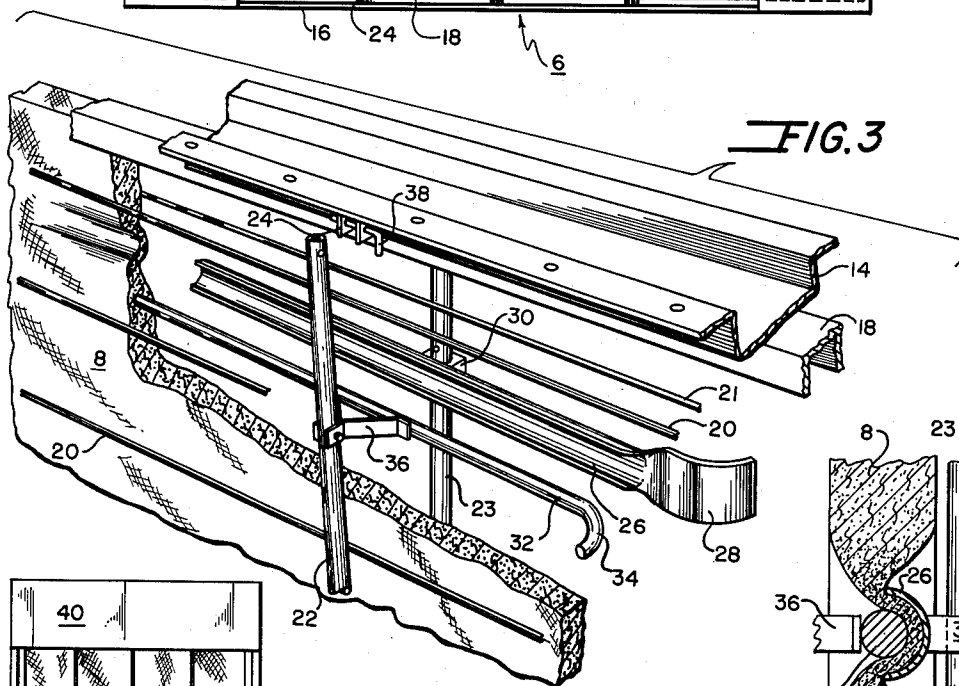
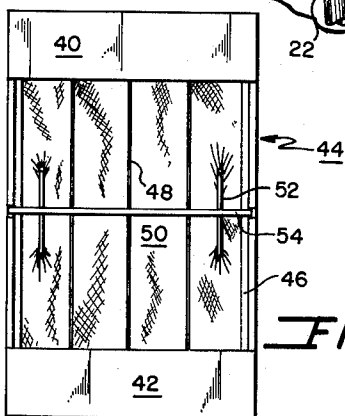
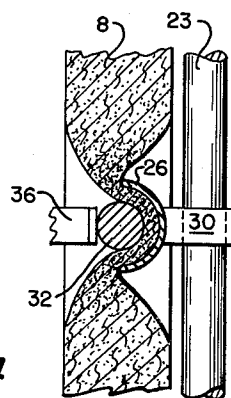


FIG. 4



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3,063,222

AIR FILTER APPARATUS

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This invention relates generally to automatic air filters of the disposable medium type employing, as an air filtering medium, a flexible, elongate, relatively thick, resilient web adapted to be progressively moved into and through an air stream aperture. More specifically, the invention deals with the provision of means, in connection with such filters, for restraining lateral displacement and width distortion of the air cleaning web in the air stream, both during movement of the web and while it is stationary.

Within the past five or six years automatic air filters of the so-called roll type employing media of the resilient, self-expanding type have been widely sold and used. Many of these filters utilize a filamentous fiber glass mat or web such as, for example, the web disclosed in Jackson U.S. Patent No. 2,798,531, issued July 9, 1957. Others use webs formed of synthetic fibers. In most cases the supply of filter medium is furnished in a tightly wound, compressed condition on a roll mounted in a supply zone at one end of the filter, is withdrawn from the roll and moved through a central air cleaning zone in a resiliently expanded condition, and is finally directed into a discharge zone at the opposite end of the filter where it is flattened and manipulated into a compact package which facilitates its disposal.

While it apparently makes no difference from an air cleaning standpoint whether the air cleaning medium or web is or is not compressed in the supply or discharge zones, it is usually desirable that the web be in a substantially expanded thickness state while in the air flow zone to provide whatever maximum depth of web is available. As in many devices of a relatively new nature, certain problems have arisen in commercial operation of filters employing such relatively thick webs. Because of the fibrous nature of the webs and the commonly used arrangement for advancing it into the air stream (i.e., pulling the web by means of a rewind or take-up spool in the discharge zone of the filter with the web held back at least to some extent to obtain a degree of compression on the rewind spool as it is wound thereon), "necking" (i.e., width reduction) of the web in the air stream, with an accompanying loss of air seal along the edges, has been a recurrent problem. While laterally-spaced, longitudinally-extending thin wires bonded to the web has, in part, alleviated this problem, they have not entirely eliminated it.

Another problem experienced with filters of this general type when they are horizontally disposed (wherein the web lies in a vertical plane but is advanced in a horizontal direction between horizontally spaced supply and take-up spools), results from sagging or drooping of the web from its own weight and the weight of the collected dust so that the upper edge of the web sags out of the upper horizontal air seal member of the filter frame structure. Again, wires bonded to the web have helped in connection with this problem, although not to the extent they have helped in connection with vertical filters wherein the web is advanced from a top supply zone to the bottom discharge zone.

Still another troublesome condition exists when the web tends to be rewound somewhat spirally on the rewind roll, i.e., when succeeding turns of the web on the rewind roll are offset in an axial direction. This condition is reflected in the air flow zone by the web tending to pull

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out of one or the other of the edge seal members to an increasing degree as additional used web is rewound.

While it is noted these problems do not exist in many installations of the filter apparatus, they are often considered as being serious where they do exist.

It is one object of this invention to minimize the above difficulties encountered in the use of resilient thickness media in filters of the character described.

It is another object to provide apparatus for use in connection with filters of the character described to minimize width distortion of media and its displacement from edge seals, and to provide an improved arrangement for maintaining the desired path of media travel.

I am well aware that the problem of displacement of an edge of filter medium from its intended line of travel when utilizing a movable web is not new. Thus, in the use of relatively thin media of certain types, restraining channels have been proposed to be constructed to hold, in laterally captured relation, a beaded or enlarged edge provided along the longitudinal edges of the media. In other cases the opposite longitudinal marginal portions have been proposed to be of a sufficiently impervious nature that a correspondingly disposed suction slot engaging the margins provides an air tight seal and prevents lateral displacement of the edges. And as one further illustration, Rivers U.S. Patent 2,807,330, issued September 24, 1957, discloses channel-like, longitudinal edge seals which include a flanged element directed into the depth of the expanded web to provide a seal and to prevent the lateral escape of the web edges from the channels.

In the above noted prior art structures, it will be observed that the means to restrain lateral displacement and width distortion of the medium are located, for all practical purposes, at the extreme edges of the medium. Consequently, considering the noted Rivers patent as an example of this arrangement wherein a relatively thick, resilient web is used, a slight inward force rather easily pulls or "snaps" the edge of the web from the sealing channel, and the flange directed into the depth of the web will prevent the return of the web margin back into the sealing channel without manual attention.

In accordance with the present invention, the improved means to restrain lateral shifting and width distortion of the web are spaced inwardly some distance from the means which provide the seal for the edges of the medium. In one aspect, the invention is based on the proposition that with the rather thick, resilient webs used in such filters, superior results in keeping the web in a proper position, both during longitudinal advance and while stationary, can be obtained by divorcing the functions of sealing the longitudinal edges of the web, and restraining lateral displacement of the web. Consequently, the means for sealing the edges of the web against air flow therearound are retained but additional means are provided in spaced relation therefrom to prevent lateral displacement of the web. In one preferred form these additional means comprise a semi-cylindrical hollow member mounted adjacent to and in engaging relation with one face of the web in the air stream, and a cooperating member on the opposite face of the web adapted to be moved into and held in generally nesting relationship with the concave side of the hollow member in spaced relation therefrom so as to substantially compress therebetween a longitudinally extending strip of web. The leading or web entry ends of these members (i.e., the ends between which the web first passes as it is advanced) are flared or bent outwardly so that the web is progressively compressed as it enters between the members and resistance to web advance is held to a low value.

The invention will be explained in some detail in connection with the accompanying drawing illustrating ap-

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paratus incorporating the invention in several embodiments by way of example, and wherein:

FIGURE 1 is a partly broken, somewhat diagrammatic elevational view of a horizontally arranged filter including the inventive apparatus;

FIGURE 2 is a somewhat diagrammatic plan view of the apparatus of FIGURE 1;

FIGURE 3 is a fragmentary perspective view of one embodiment of the apparatus of the invention;

FIGURE 4 is a vertical sectional view taken along the line 4—4 of FIGURE 1;

FIGURE 5 is a somewhat diagrammatic elevational view of a vertically disposed filter utilizing the inventive apparatus along both side portions of the air stream aperture.

Referring to the drawing, FIGURES 1 and 2 illustrate one example of a roll type filter horizontally arranged with a supply roll 2 of air cleaning medium or web in tightly wound form mounted in the right end section 4 from which the web is advanced incrementally from time-to-time into and through the central section 6 framing the air stream aperture, the web designated by the numeral 8 in the air stream assuming its expanded thickness form in the air stream. As the web 8 is progressively advanced through the central section and filters air borne contaminants from the air stream, it is correspondingly progressively advanced into the left end section 10 wherein it is tightly wound into a discharge roll 12 which is ultimately thrown away or reconditioned.

The central section 6 is framed along the top and bottom by oppositely disposed channel elements 14 and 16 respectively secured at their ends to the end sections 4 and 10. A web edge air seal channel 18 having a width corresponding approximately to the expanded thickness of the web is mounted to extend longitudinally along the inner surface of each of the frame members 14 and 16 (only the upper one shown in FIGURE 3) in inwardly open relationship to receive the extreme longitudinal margins of the web in the central section. Thus the channels 18 serve as seals along the longitudinal margins of the web to prevent the flow of dirty air therearound.

To provide support against displacement of the web in the normal and reverse directions of air flow, front and rear wires or small diameter rods 20 and 21 secured at their opposite ends adjacent the respective end sections are disposed to extend longitudinally along the front and rear faces of the web. The front wires 20 extending along the front face of the web are appropriately spaced from each other across the width of the web, and are spaced from the corresponding rear wires 21 a distance corresponding approximately to the resiliently expanded thickness of the web. Such support wires are conventional, and further detail as to the mounting arrangement, etc., is not deemed necessary.

One or more stiffening members extending in a widthwise direction relative to the direction of medium advance in the center section may be provided along the front and rear of the center section to maintain the spacing between the upper and lower frame members 14 and 16 and to stiffen the center section. These members, which may be in the form of front and rear tubes 22 and 23, are secured at their upper and lower ends in brackets 24 mounted along the front and rear edges of the center section forming channels 14 and 16.

Having now described the general structure of the filter apparatus as a whole, attention will be directed to the means for preventing width distortion of the web and loss of edge seals. In one preferred arrangement, a semi-cylindrical member 26, which may be conveniently made by cutting a piece of conduit or tubing along its longitudinal axis, has one end flattened and formed as illustrated in FIGURE 3 to include a portion 28 flared radially outwardly. The member 26 is mounted with its open side having a concave surface engaging the rear face of the web with its flared portion 28 directed toward the supply

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roll end of the filter apparatus and with its longitudinal axis substantially parallel with the center section framing members 14 and 16 and consequently parallel to the direction of web travel. The member 26 may be conveniently mounted in this disposition by securing a block 30 to the outer curved surface of the member at an intermediate location therealong and then mounting the block on a rear tube 23.

The opposing member positioned to engage the front face of the web preferably takes the form of a smaller diameter elongate rod 32 having its leading end 34, opposite the flared portion 28 of member 26, bent into a shape similar to the leading end of a sled runner. This rod 32 is mounted by suitable means, such as the metal straps 36, to a front tube 22 so that when the rod 32 is in operative position it is substantially nested within the concave space formed by member 26 and leaves a narrow U-shaped space between the members.

In accordance with the principles of the invention, the semi-cylindrical rear member 26 and opposing front member 32, which may be collectively termed a runner set, are spaced downwardly from the upper channel a sufficient distance that a considerable lateral displacement of the web downwardly would be required for the upper longitudinal edge of the web to approach the runner set, but is not spaced downwardly a distance which would leave sufficient web to sag or droop from its weight plus the weight of the dirt load. As an example of the downward spacing of the runner set, with a web of, say 2 to 3 inches in thickness and in the range of 3 to 5 feet in width, the runner set may be spaced downwardly about 3 to 8 inches below the bight of the edge sealing channel 18 with quite satisfactory results in service. Of course, the runner set may be even lower so long as the web above the runner set does not sag. The exact spacing for satisfactory results obviously depends to some extent upon the sagging characteristics of the web itself.

FIGURE 4 illustrates the cross sectional configuration which the web assumes as it passes along and between the opposed members forming a runner set. In the illustration, the rod 32 is nested within the half conduit 26 with their axes substantially aligned with the spacing between the opposed concave and convex surfaces of the respective members being equidistant throughout. As an example of the spacing which may be employed between the opposed members in relation to the thickness of the medium with a glass fiber web of the type formed in practicing the process disclosed in Jackson U.S. Patent 2,798,531 and resulting in a web of about 2½ to 3 inches in its resiliently expanded form, the members may be arranged to provide a ½ inch open space between the opposed surfaces. It will be appreciated that the exact spacing is subject to some variance depending upon the resiliency of the particular medium involved; with a stiffer medium (often due in part to variations in the binder material used to bond the glass fibers to each other in the web), the spacing may be increased.

It is noted that with the narrow strip of web compressed to a minor part of its resiliently expanded thickness for the length of the runner set, and bounded along the top and bottom of the runner set by web in a relatively expanded condition, it would require substantial lateral forces to cause the web to shift laterally relative to the runner set. This may be contrasted to the negligible force required to progressively compress a narrow portion of web as it enters the leading end of the runner set. Since the friction of compressed web against longitudinal advance in the runner set is slight (the web commonly being coated with an oil-like substance for retention of trapped dirt), and little force is required to incrementally compress the narrow strip, the web may be advanced satisfactorily with the conventionally powered drives for such filter apparatus.

In accordance with one feature of the invention, the front runner 32 is secured to a front rod 22 which is pivot-

ally secured in its lower bracket 24 so that it can be swung out and downwardly to move the rod 32 away from the rear runner 26. The corresponding upper bracket 24 is adapted to receive a pin 38 which can be removed therefrom to release the upper end of front tube 22 when desired, and can then be inserted to again secure the upper end when new web has been installed in the filter apparatus and it is desirable to again position the rod 32 to squeeze the strip of web within the runner set.

FIGURE 2 shows a horizontal filter apparatus employing only one runner set for the entire length of the filter. While this has been found to be sufficient in connection with the dimensions of most such filters now employed and in view of the character of most media now employed, it will be appreciated that several such runner sets can be used at longitudinally spaced locations; or that one runner set of extended length can be used.

The principles of the invention are also applicable to filter apparatus arranged vertically where sagging of the web, in the sense of a substantially unsecured upper edge drooping, is no problem but necking of the web is encountered. As illustrated in FIGURE 5, a vertically arranged filter commonly has a medium supply section 40 at the top, a used medium discharge section 42 at the bottom, and an air stream aperture 44 defined along the vertical edges by inwardly open channels 46 for sealing the vertical edges of the medium against dirty air flow therearound. The usual upstream and downstream rods 48 are provided to support the medium 50 against displacement in the normal and reverse directions of air flow. A set of runners or guides 52 is mounted near each vertical side of the filter, generally as shown in FIGURE 5, so that the tendency of the medium to neck in from the vertical side seals 46 is resisted. The general form of the front and rear elements of the runner set 52 is as illustrated in FIGURE 3 with the outwardly flared portions of the elements being at the upper end, i.e., being closer to the supply section 40. Preferably, the two front rods of the runner sets 52 are mounted on a detachable cross rod 54 so that new medium may be inserted into the apparatus more easily.

The invention claimed is:

1. In an air cleaning device of the type employing an elongate, resilient thickness, air cleaning web adapted to be progressively advanced longitudinally in a substantially expanded thickness state through an air stream aperture: inwardly directed flange means along the opposite longitudinal edges of said aperture for engaging, in lapping relationship, the opposite longitudinal margins of said web to prevent the flow of uncleaned air there around; means for restraining said web against lateral displacement in said aperture including opposing members disposed on opposite faces of said web to engage an elongate narrow strip of web therebetween in a generally trough-shaped substantially compressed condition; means mounting said opposing members in parallel, closely spaced relation with their axes generally parallel to the direction of web travel, and adjacent to but spaced from said aperture longitudinal edge a distance greater than the resiliently expanded thickness of said web, said mounting means including means maintaining said opposing members in fixed engaging relation with said web both while it is being advanced and while stationary.

2. In an air cleaning device of the type employing an elongate, resilient thickness, air cleaning web adapted to be progressively advanced longitudinally in a substantially expanded thickness state through an air stream aperture: air flow seal means in the form of inwardly open channel members along the opposite longitudinal edges of said air stream aperture, said channel members having a width approximately equal to the resiliently

expanded thickness of said web so that the longitudinal margins of said web are received therein and are longitudinally shiftable therewith without any substantial compression thereof; separate means for restraining lateral displacement of said web in said aperture including at least a pair of opposing members disposed to engage opposite faces of said web and to substantially compress an elongate, narrow strip of said web in generally pleated form; mounting means for securing said separate means in spaced, generally parallel relation to said air flow seal means with the expanse of resiliently expanded web between said narrow compressed strip and the adjacent air flow seal means being greater than the resiliently expanded thickness of said web, said mounting means including means maintaining said spacing of said opposing members both while said web is being advanced and while stationary.

3. In the air cleaning device of claim 2: said mounting means include separate mounting means for said opposing members, and at least one of said mounting means is releasably secured relative to the other.

4. In the air cleaning device of claim 2: said opposing members comprise an elongate hollow, semi-cylindrical member disposed with its open side forming a concave space in engaging relationship with one face of said web, and an element having a side forming a convex surface of reduced diameter relative to said concave space disposed on the opposite face of said web and adapted to be placed in substantially nesting relation with said hollow member to form a curved space therebetween for compressing said web to a minor portion of its resiliently expanded thickness.

5. In the air cleaning device of claim 4: said opposing members include end portions directed away from the respective faces of said web at the web entry ends for providing progressive compression of said web as it is advanced into engaging relation therewith.

6. In an air cleaning device of the type employing an elongate, resilient thickness, air cleaning web adapted to be progressively advanced longitudinally in a substantially expanded thickness state through an air stream aperture: inwardly directed flange means along the opposite longitudinal edges of said aperture for engaging, in lapping relationship, the opposite longitudinal margins of said web to prevent the flow of uncleaned air therearound; means for restraining said web against lateral displacement in said aperture including a trough-shaped hollow member and an element of sufficiently reduced cross section relative to said hollow member to permit substantial nesting therewithin to form a narrow passage of generally sinuous cross-section therebetween; means mounting said restraining means with its axis extending generally in the direction of web travel, adjacent to but spaced a distance greater than the resiliently expanded thickness of said web from one of said aperture longitudinal edges, and with said hollow member and element engaging opposite faces of said web to compress a narrow strip of web therebetween to a minor portion of its resiliently expanded thickness.

7. In the air cleaning device of claim 6: said trough-shaped hollow member includes an interior surface of semi-circular shape.

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