March 7, 1967 J. M. COCITO 3,307,819

DISC VALVE FOR VACUUM BOARD

Filed April 12, 1965

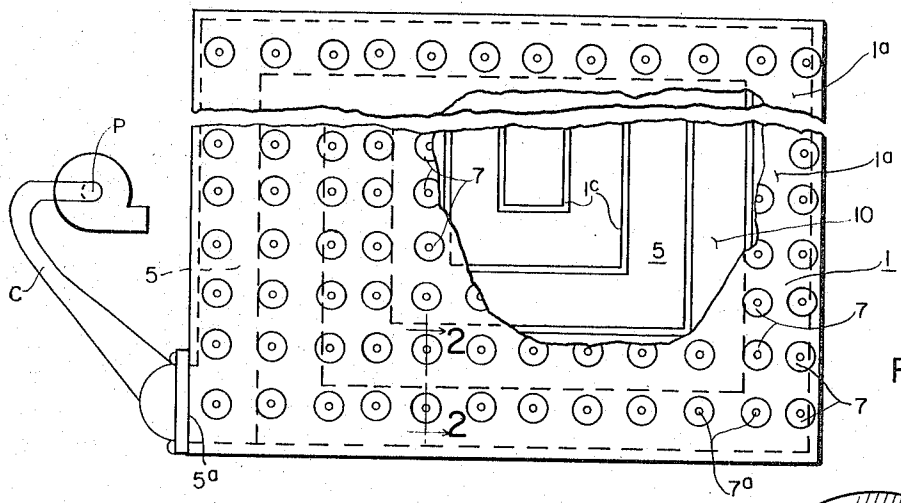

Fig. 1

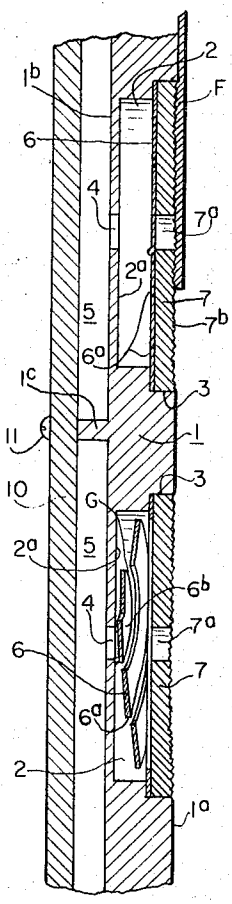

Fig. 2

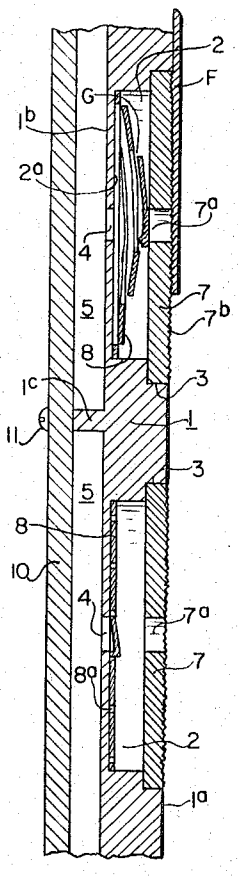

Fig. 3

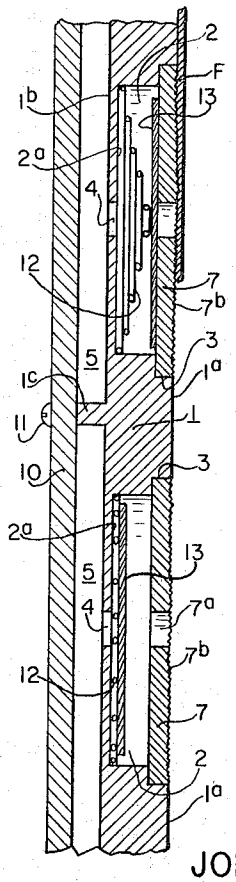

Fig. 4

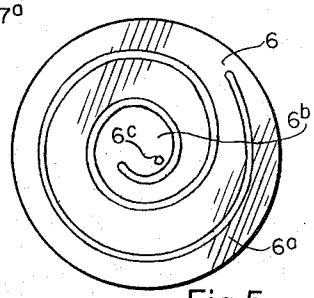

Fig. 5

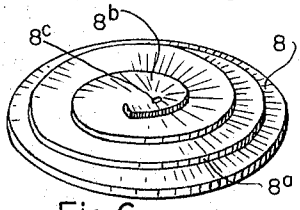

Fig. 6

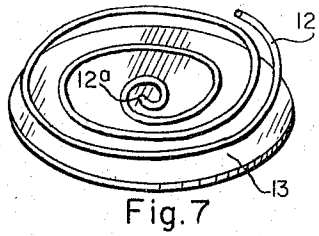

Fig. 7

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DISC VALVE FOR VACUUM BOARD

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This invention relates to vacuum holders for thin flexible photographic sheets or films of the type having a large number of suction holes distributed over the surface of a supporting plate, and more particularly relates to improved valve means for automatically reducing the flow of air into vacuum holes which are not covered by a photographic sheet being supported by the holder.

It is a principal object of this invention to provide a holder of the above type in which novel and improved automatic valve means are provided at each suction hole to virtually close the bore extending from the front face of the plate into a vacuum manifold located behind the plate whenever no film or sheet overlies and closes the bore, and said valve means automatically opening when a film is laid thereover.

I am aware that there are a number of prior-art patents showing structures which operate in this same general way, for instance Patents 2,910,265, 2,753,181, 2,782,574, 2,694,337, 2,425,921 and 2,198,765, but the present valve structure is an improvement from the point of view of simplicity and from the point of view of being self-cleaning to a greater extent. One of the most serious problems encountered in connection with valved vacuum-board structures results from their tendency to collect dust in the bores of the suction holes with the result that the valves become jammed or the bores clogged, or both.

The present invention teaches simplified valve means which by virtue of improved structure have less tendency to become jammed. The present valve means takes the form of a disc member located within a major bore portion, and having a spring feature which maintains the valve means in open position, either the whole disc or a portion thereof being displaceable by vacuum in the manifold toward a closed position at which the valve means imperfectly closes the bore, thereby leaving a small leakage space. This structure provides the desired valving action, without however, completely closing the bore to the flow of air so that when the outer end of the bore is closed by a film laid thereover, the air between the valve means and the film will leak into the manifold by passing through the imperfect seating zone where the valve means attempts to seat against a shoulder within the bore portion, and thus release the air pressure holding the valve means against the shoulder to permit the valve to open. When the valve is in open position, the bore at the shoulder represents a large opening which freely passes any collected dust or lint into the manifold.

The present disclosure shows the improved valve means coupled with an advantageous manifold structure located behind the pattern of suction holes and communicating with the bores therethrough. This structure comprises a continuous manifold including a lengthy channel which is folded in a serpentine manner and communicates with all of the suction points sequentially. A vacuum is drawn upon the channel at one end, and the channel is of such small cross-sectional area that when the system is first turned on, the evacuating effort will be applied initially to a relatively few valve means near the beginning of the serpentine channel. When these valve means have closed, the vacuum gradient will move along the channel causing each valve means which it approaches to close in a sequential manner. Therefore, the vacuum pump need not be capable of closing substantially all of the ball valves simultaneously, but rather the pump need be capable only of closing a few of the valve means at any one time.

Another object of this invention is to provide a relatively simple and easily machined structure which can be economically manufactured using inexpensive materials. One improvement in the present structure is the provision of press-fit washer means for holding the valve balls in the bores, the washers being pressed into recesses at the film supporting end of each of the bores. These washers may be knurled or otherwise roughened on their outer surfaces so that when a film is laid over the washer, the vacuum from the central hole therethrough can spread outwardly through the grooves provided in the front face of the washers by the surface knurling, but these grooves are so small and shallow as compared with the diameter of the hole through the washer that in the event that the film overlies only a portion of the washer including the hole therethrough, the holding effect of the vacuum upon the film will not be lost by escape through those knurled areas of the washers which are not covered by the film.

Another advantage of the present invention is that virtually all of the necessary machining can be performed upon both sides of one main panel member, the other panel member requiring no machining except a few holes drilled therein to facilitate screwing of the rear closure panel to the front panel to complete the enclosure of manifold channels.

Other objects and advantages of the present invention will become apparent during the following discussion of the drawings, wherein:

FIG. 1 is a broken elevation view of a vacuum film holder according to the present invention connected with an external vacuum pump, a portion of the front panel of the holder being cut away to show the manifold construction;

FIG. 2 is an enlarged sectional view taken along the line 2—2 of FIG. 1, this figure showing the upper valve in open position and the lower valve in closed position;

FIG. 3 is a sectional view similar to FIG. 2, but showing a first valve-structure modification with the upper valve in open position and the lower valve in closed position;

FIG. 4 is a sectional view similar to FIG. 2 but showing a second valve-structure modification with the upper valve in open position and the lower valve in closed position;

FIG. 5 is a plan view of a valve disc as used in FIG. 2;

FIG. 6 is a perspective view of a valve member as used in FIG. 3; and

FIG. 7 is a perspective view of a valve member as used in FIG. 4.

Referring now to the drawings, the figures show preferred embodiments of the invention which include two panel members. The front panel member **1** has a large number of holes, arranged in a closely proximate pattern and passing all the way through it. Each of the holes comprises a main bore portion **2** meeting an enlarged outer portion **3** and a small inner portion **4**, these bore portions extending from the front surface **1***a* of the panel **1** through the rear surface **1***b* thereof. The rear surface has a series of serpentine channels **5** therein which are separated by ribs **1***c* and which form a continuous passage commencing in the center of FIG. 1 and winding around the figure and eventually opening into an evacuation outlet **5***a* which connects to a suitable vacuum pump P through a suitable conduit C. The rear surfaces of the ribs **1***c* mate with a rear closure panel member **10**, and the front and rear panels are held together by any suitable means such as screws **11** as shown in FIGS. 2, 3, and 4.

The manner in which the present valved board is intended to operate is basically similar to the functioning of numerous other vacuum holders such as the ones illustrated in the patents mentioned above in which valve means are provided to automatically close any of the bores which have not been covered by film sheets F or other relatively non-porous webs overlying the front face 1*a* of the panel 1.

In the present disclosure the valve means shown in FIGS. 2 and 5 by which the closing of the uncovered bores is accomplished includes a flat disc 6 located at each of the major bores 2 and held at its periphery in the larger bore portion 3 by a retainer washer 7 having a hole 7*a* therethrough and having a knurled front face 7*b*. The disc 6 has a spiral slot 6*a* therethrough, and is made of a very thin spring-like sheet material, such as beryllium copper, so that its central area 6*b* can be distorted toward and against the end of the bore 4 at the shoulder 2*a* when a vacuum is drawn upon the manifold 5 and when the hole 7*a* is uncovered. The disc 6 also has a dimple 6*c* in its innermost convolution so as to prevent the surface 6*b* from seating perfectly against the shoulder 2*a*. This imperfect seating is best seen at the lower half of FIG. 2, and serves the purpose of permitting the air to be exhausted from the bore 2 in the event that a sheet F should be placed over the hole 7*a*, thereby permitting the valve means to automatically open when the hole 7*a* is covered up.

FIG. 3 shows a first modified form of the invention, in which like reference characters refer to similar structure. However, the disc member 8 which comprises the valve means is not flat in relaxed condition as is the disc member 6. Rather it is provided with a permanent set so that its convolutions formed by the spiral slot 8*a* assume somewhat conical relative locations as shown in FIG. 6. In relaxed condition, the member 8 fits in and snugly grips the bore 2 as shown at the top of FIG. 3, and the central portion 8*b* contacts the washer 7 in open position. When the valve member 8 moves to closed position as shown below in FIG. 3, it lies almost flat against the shoulder 2*a*, but is prevented from perfect seating by the dimple 8*c*.

FIG. 4 shows a second modified form of the invention in which structure which is similar to that shown in FIG. 2 is provided with the same reference numeral. This second modification is also essentially a disc with reciprocates axially of the bore portion 2 to assume an open position as shown at the top of FIG. 4 wherein the coil spring 12 pushes this disc 13 yieldably toward the washer 7, but whereby the vacuum can pull the disc 13 to the left to assume an imperfectly closed position as shown below in FIG. 4 wherein the valve leaks between convolutions of the spring 12. The disc 13 is slightly smaller in diameter than the bore portion 2, and the spring 12 comprises a cone-shaped helix made of small diameter spring wire, for example, 6 thousandths of an inch in diameter. Preferably, the spring 12 should be wound such that the outer convolutions are closer together than the inner convolutions, whereby when the valve is closed as shown below in FIG. 4, any dust which can pass between the outer convolutions to enter the space between the disc 13 and the shoulder 2*a*, can easily flush through the increasingly wide space between inner convolutions and thereby reach and pass through the bore 4. The disc 13 is supported and centered by the spring 12 which is welded or otherwise attached to its center, as at 12*a*.

OPERATION

The reasons for the novel structures of the present disclosure will be further clarified during the following explanation of operation. As is recognized in the prior art, if unlimited vacuum pump facilities are available, it is not necessary to close the exposed bore holes through the front panel member in locations not overlapped by the film F, but since it is desirable to use only a relatively small vacuum pump P in a practical installation, the closure valves shown in the bores become necessary in order to conserve the vacuum, especially when only a small proportion of the bores through the front panel member are covered by a film F.

In practical working embodiments of the present invention, the chanels 5 are milled into or built up upon one of the panel members 1 or 10, but only to a depth of about ⅛ inch, and the width of each channel is about five inches. Since the channels are of relatively small cross-sectional area, they exhibit considerable impedance to the flow of air therethrough with the result that when the vacuum pump P is first started, the end of the channel nearest the conduit C drops in pressure considerably ahead of the time that the pressure begins dropping in the more remotely located channel portions. Thus, even a small pump P, such as a domestic vacuum cleaner, can sequentially close the valves located along the channel without having to first evacuate the entire manifold to do so. Hence, when the pump P is started, the valves close first in the outer channels, and then successively close in a sequence winding around the panels and approaching the center of the panel members.

Referring now to FIGS. 2, 3, and 4, these figures illustrate novel valve structures having very practical features. Experience has shown that the presence of dust in most valve structures is highly damaging to their operation, and eventually renders the device inoperative. A major advantage of the present structure is that the valving action takes place between several parts which move relative to each other, while the valve moves between open and closed positions in such a way as to dislodge any dust commencing to accumulate. In other words, there is a sort of "working" action between spring convolutions and between the disc members and the walls of the bore and shoulder which action encourages the air jetting passed these parts to flush out the clearance space. A suitable set of dimensions would be a diameter of ⅜ inch for the bore 2, the disc 13 being a few thousandths of an inch smaller in diameter. The bore 4 can be drilled by a number 30 twist drill and is therefore about .128 inch in diameter, and the washer 7 is 7/16 inch in diameter with a central hole 7*a* of the same diameter as the bore 4. The axial length of the bore 2 should be no less than the maximum radial space between convolutions of the spring 12 in the showing of FIG. 4, and should be great enough in the forms shown in FIGS. 2 and 3 to permit a substantial gap G to develop between convolutions of the disc springs 6 and 8 to pass dust through the manifold 5.

The slotted structure of the discs 6 and 8 shown in FIGS. 2, 3, 5, and 6 can be easily accomplished by chemically etching the slots 6*a* and 8*a* into beryllium copper discs.

The outer surface 7*b* of each of the washers 7 is knurled so that minute grooves will be provided on the outer surface of each washer 7 permitting a vacuum to be drawn on the film F over as much of the surface area of the washer 7 as is covered thereby, and not merely over the relatively small area of the hole 7*a*. Some prior art patents have shown other types of roughening of the outer surface in the vicinity of each suction hole, but many of these structures require expensive concentric-groove machining of the front plate itself. The present invention is believed to constitute a practical improvement by requiring only inexpensive knurling of the washers themselves before they are installed in the bores 3 of the front panel.

The present invention is not to be limited to the exact structure shown in the drawings, for obviously changes may be made therein within the scope of the following claims.

I claim:

1. A vacuum board for holding flexible sheets in a plane, comprising:

(a) a panel member having plural suction holes therethrough, each including a bore extending from the front face of said member therethrough to the rear and having a shoulder therein at a location where the bore changes from a larger front bore portion to a smaller bore portion extending through the rear of the panel member;

(b) vacuum manifold means on the rear of the panel and communicating with said bores;

(c) disc and spiral spring means in said larger bore portion, the disc means fitting snugly therewithin and having a central area located opposite said smaller bore portion and urged away therefrom by said spring means, and said disc and spring means being movable by air-flow in the larger bore portion toward said manifold means to displace said central area toward said shoulder and restrict the smaller bore portion; and

(d) means for preventing perfect seating of the disc means on the shoulder in the vicinity of the smaller bore portion.

2. In a board as set forth in claim 1, said disc and spring means comprising a thin flat disc of spring-like sheet material with a spiral slot extending from a location near to but offset from its center through plural convolutions to a point near the perihpery of the disc, and the disc being supported at its periphery in the larger bore portion parallel to and spaced from the shoulder, and the central area of the disc being displaceable by the vacuum in the manifold means into contact with the shoulder to overlie the smaller bore; and said preventing means comprising a distortion of the central area thereof to provide imperfect seating against the shoulder.

3. In a board as set forth in claim 1, said disc and spring means comprising a thin disc of spring like sheet material with a spiral slot extending from a location near to but offset from its center outwardly through plural convolutions, and the disc being supported in the larger bore portion with its periphery against the shoulder, the central area of the disc being normally out of contact with the shoulder at the smaller bore and being displaceable by the vacuum in the manifold means into contact therewith; and said preventing means comprising a distortion of the central area of the disc to provide imperfect seating against the shoulder.

4. In a board as set forth in claim 1, said disc and spring means comprising a flat disc sized to slide freely in said larger bore portion, a spiral spring having its center attached to the central area of the disc and spiralling through plural convolutions away therefrom and terminating in an outer convolution sized to grip the wall of the larger bore portion and disposed at said shoulder, and the spring normally holding the disc remote from the shoulder but yielding to permit flat nesting of its convolutions between the shoulder and the disc when the latter is attracted toward the former by the vacuum manifold means, said preventing means comprising the nested convolutions of the spring leaving a leakage space therebetween.

5. In a board as set forth in claim 4, the spiral spring being wound such that the space between its convolutions when nested increases from minimum spacing near the outer convolutions to maximum spacing near the inner convolutions.

6. A vacuum board for holding flexible sheets in a plane, comprising:

(a) a panel member having plural suction holes therethrough, each including a bore extending from the front face of said member therethrough to the rear and having a shoulder therein at a location where the bore changes from a larger front bore portion to a smaller bore portion extending through the rear of the panel member;

(b) vacuum manifold means on the rear of the panel and communicating with said bores;

(c) vacuum-operated valve means in each suction hole and comprising disc and spring means contained within a larger portion of the bore, the spring means having plural convolutions with an outer convolution contacting the bore to maintain the spring means in place therein and an inner convolution yieldably urging a central portion of the disc means away from the shoulder, said central portion being large enough to cover the end of the smaller bore portion at the shoulder; and

(d) means for preventing perfect seating of the central portion of the disc means on the shoulder in the vicinity of the smaller bore portion.

7. In a board as set forth in claim 6, said disc and spring means comprising a thin flat disc of spring-like sheet material with a spiral slot extending from a location near to but offset from its center through plural convolutions to a point near the periphery of the disc, and the disc being supported at its periphery in the larger bore portion parallel to and spaced from the shoulder, and the central portion of the disc being displaceable by the vacuum in the manifold means into contact with the shoulder to overlie the smaller bore; and said preventing means comprising a distortion of the central portion thereof to provide imperfect seating against the shoulder.

8. In a board as set forth in claim 6, said disc and spring means comprising a thin disc of spring-like sheet material with a spiral slot extending from a location near to but offset from its center outwardly through plural convolutions, and the disc being supported in the larger bore portion with its outer periphery against the shoulder, the central portion of the disc being normally out of contact with the shoulder at the smaller bore and being displaceable by the vacuum in the manifold means into contact therewith; and said preventing means comprising a distortion of the central portion of the disc to provide imperfect seating against the shoulder.

9. In a board as set forth in claim 6, said disc and spring means comprising a flat disc sized to slide freely in said larger bore portion, a spiral spring having its center attached to the central portion of the disc and spiralling through plural convolutions away therefrom and terminating in an outer convolution sized to grip the wall of the larger bore portion and disposed at said shoulder, and the spring normally holding the disc remote from the shoulder but yielding to permit flat nesting of its convolutions between the shoulder and the disc when the latter is attracted toward the former by the vacuum manifold means, said preventing means comprising the nested convolutions of the spring leaving a leakage space therebetween.

10. In a board as set forth in claim 9, the spiral spring being wound such that the space between its convolutions when nested increases from minimum spacing near the outer convolutions to maximum spacing near the inner convolutions.

11. A vacuum board for holding flexible sheets in a plane, comprising:

(a) a panel member having plural suction holes therethrough, each including a bore extending from the front face of said member therethrough to the rear and having a shoulder therein at a location where the bore changes from a larger front bore portion to a smaller bore portion extending through the rear of the panel member;

(b) vacuum manifold means on the rear of the panel and communicating with said bores;

(c) vacuum-operated valve means in each suction hole and comprising disc and spring means contained within a larger portion of the bore, the disc means having a central portion sized to cover the end of the smaller bore at the shoulder and having the central portion distorted to prevent perfect seating thereagainst, and

the spring means yieldably urging the central portion of the disc means away from the shoulder and from the smaller bore portion; and

(d) means for covering the fronts of each of the bores comprising washers pressed into the bores flush with the front of the panel member and having openings of cross-sectional area at least equalling the associated smaller bore portions.

12. In a board as set forth in claim 11, said panel member having an enlargement at the front of each larger bore portion, said disc and spring means comprising a thin flat disc of spring-like sheet material with a spiral slot extending from a location near to but offset from its center through plural convolutions to a point near the periphery of the disc, and the disc being supported at its periphery in said enlargement parallel to and spaced from the shoulder, and the central portion of the disc being displaceable by the vacuum in the manifold means into contact with the shoulder to overlie the smaller bore; and said washer being pressed into said enlargement against the periphery of the disc.

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