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3,307,818

VACUUM BOARD MANIFOLD

Filed March 19, 1965

2 Sheets-Sheet 1

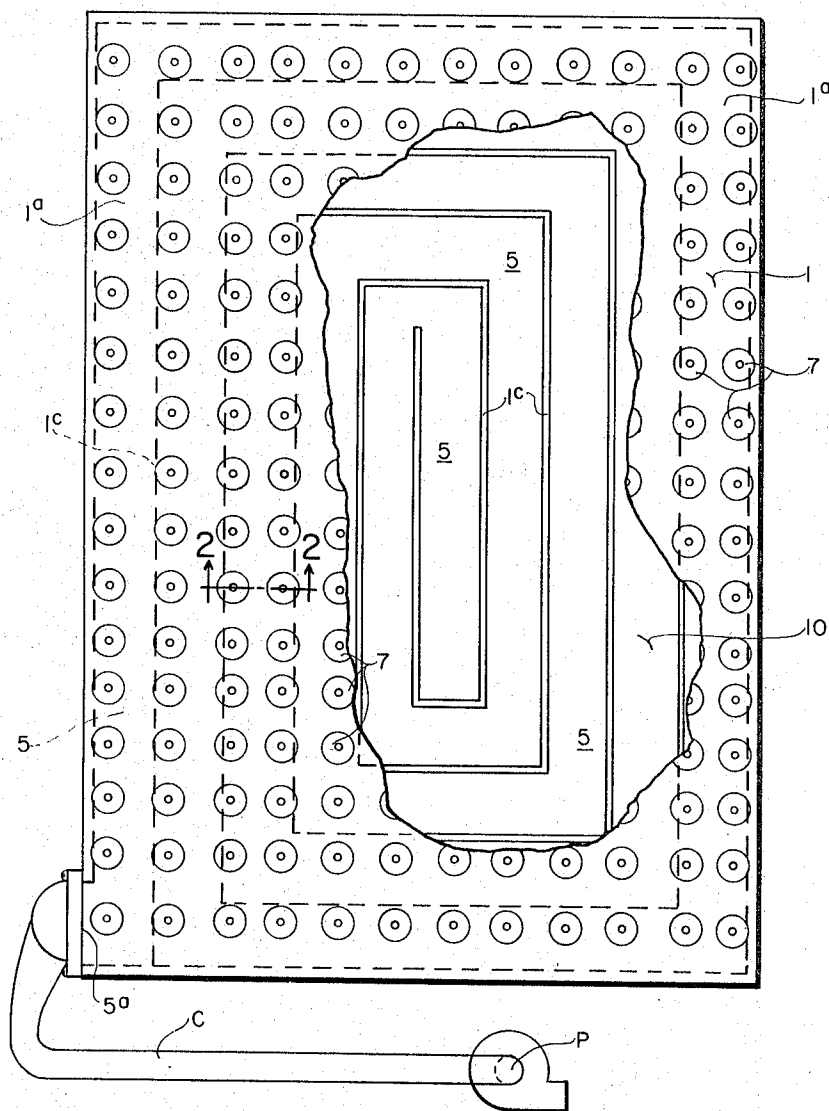


Fig. 1

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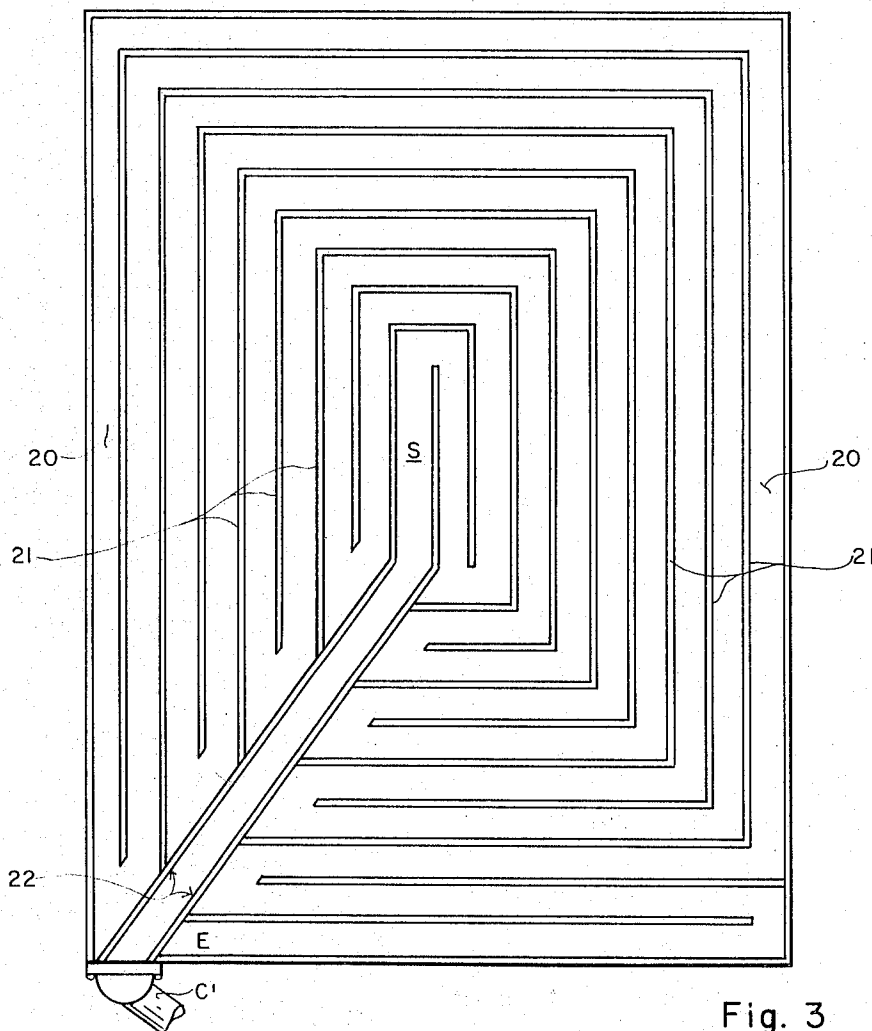


Fig. 3

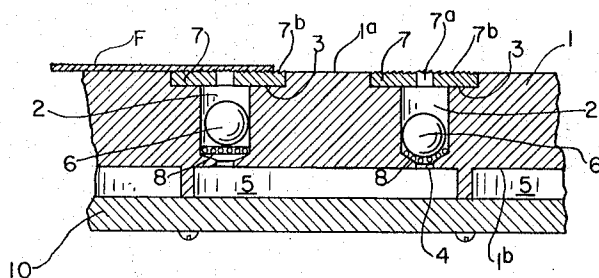


Fig. 2

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This invention relates to vacuum holders for thin flexible photographic sheets or films, and more particularly relates to holders having a large number of suction points distributed over the surface of a supporting plate and communicating with improved vacuum manifold means.

It is a principal object of this invention to provide an improved serpentine manifold in a holder of the type in which valve means are provided at each suction point to automatically close the bore extending from the front face of the plate into the vacuum manifold whenever no film 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, 2,594,337, 2,425,921, and 2,198,765 the valve means being necessary to conserve and help maintain adequate vacuum when only a relatively few suction points are covered by a small-area film. A practical vacuum board usually has 10,000 or more suction-point holes therein, and, if only a small vacuum blower is to be used such as a domestic vacuum cleaner motor and housing, efficient means is necessary to close the uncovered holes. The present illustrative embodiment uses a valve system comprising a bore containing a ball valve which is pulled against a spring by the vacuum to restrict a smaller bore and thereby provide the desired valving effect. A leaking action between the compressed convolutions of the spring assures that when the outer end of the suction point is closed by a film laid thereover, the air between the ball and the film will leak into the manifold by passing between the spring convolutions and thus release the ball to be pushed away from said smaller bore by the spring, thereby opening the valve.

It is a more specific object of the invention to provide improved manifold means behind the pattern of suction points and communicating with the bores therethrough. Various attempts have been made in the past to improve the efficiency of the manifold means, for instance by dividing it into separate concentric compartments, and employing either manually or automatically operated valves to close or open the partitions between the various manifold compartments, as shown in Patents 2,317,348, 2,814,233, 2,895,706 and 2,914,289. The present improved structure comprises a manifold system including one or more continuous manifolds each having a single lengthy channel which is folded in a serpentine manner and communicates with all of the suction points located opposite it. A vacuum can be drawn upon the channel at either of its ends, but one of the characterizing features of the present structure is that there is no place within one manifold where two legs thereof are connected in parallel with each other.

Another feature of the improved manifold structure is that the cross-sectional area thereof at any particular location is small as compared with the cross-sectional area of many prior art structures. This fact in cooperation with the continuous serpentine channel configuration provides the following novel operations: Assuming an initial rest condition in which all of the valves are lying open and the vacuum pump is off, when the pump is first started it will immediately draw a vacuum on the valve assemblies nearest the conduit which connects the pump with the serpentine passageway, but since the passageway is not very large in cross-sectional area, there will be a considerable amount of impedance to the flow of air

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therethrough, and therefore there will initially be a relatively steep gradient between the vacuum at the beginning of the serpentine channel, and the degree of vacuum located at a point somewhat further therealong. Thus, the evacuating effort will be applied first to a relatively few valve assemblies near the beginning of the serpentine channel, and as these valve assemblies close, the vacuum gradient will move along the channel causing each valve assembly which is approaches to close in a sequential manner. Thus, it is not necessary for the vacuum pump to be capable of closing substantially all of the ball valves simultaneously, but rather the pump need be capable of closing only a few of the valve assemblies at a time. Later in the present specification an illustrative group of dimensions and proportions are specified for the purpose of describing a workable embodiment.

It is another object of this invention to provide serpentine manifold means in which the vacuum connection is located at one corner of the board, but the vacuum draws first from the center of the board and later from its outer areas. In a practical camera set up, the center of the board is not a convenient place to attach a vacuum conduit because existing camera and support equipment would be in the way, but, on the other hand, since the centermost cluster of holes is usually covered by the film sheets, the board is more apt to work well if the vacuum is drawn directly upon these locations most likely to be covered.

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 manifold structure is that the depths of the vacuum channels as measured normal to the main face of the board is only about one-eighth of an inch, whereby shallow milling will provide adequate depth for the channels. Alternatively, the partitions between channels can easily be built up by adding strips to one of the two panel members.

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 the manifold channels.

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

FIG. 1 is an 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 broken away to show interior manifold construction;

FIG. 2 is an enlarged sectional view taken along line 2—2 of FIG. 1, this figure showing one ball valve closed by the vacuum, and the other ball valve open since its hole is closed by an overlying film sheet; and

FIG. 3 is an elevation view of a modified manifold structure in which the vacuum pump draws first from the center of the board and subsequently from the peripheral areas thereof.

Referring now to the drawings, the figures show embodiments of the invention which include two panel members. The front panel member 1 has a large number of holes arranged in a preferred pattern and passing all the way through it. Each of the holes comprises a main bore 2 having an enlarged outer portion 3 and a small inner portion 4, these bore portions extending from the front surface 1a of the panel 1 through the rear surface 1b thereof. The rear surface has a series of serpentine channels 5 therein which are separated by ribs 1c and one continuous passage commencing in the center of FIG. 1

and winding around the figure and eventually opening into an evacuation outlet 5a which connects to a suitable vacuum pump P through a suitable conduit C. The rear surfaces of the ribs 1c mate with a rear closure panel member 10 which can best be seen in FIGS. 1 and 2. The rear closure panel member 10 is attached to the front panel member 1 by any suitable means such as screws 11 as shown in FIG. 2.

If it were not for the bores 2, 3, and 4, the pump P would draw a vacuum upon the channels 5 to the extent of its evacuating capability, but where there are a large number of bores it becomes expedient to control their leaking. The manner in which the present board is intended to function is 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 close any of the bores which have not been covered by film sheets F or other relatively non-porous webs overlying the front face 1a of the panel 1. Each valve assembly includes some kind of vacuum-operated piston means, such as a ball 6, located in each of the major bores 2 and fitting it fairly snugly. The ball 6 is retained in the bore 2 by a washer 7 having a hole 7a therethrough and having a knurled front face 7b. Each washer 7 is a press fit in the bore portion 3 and serves to retain the ball 6 so that it cannot fall out of the front of the board. The rear bore portion 4 is of much smaller diameter than the central bore portion 2 and joins it at a conical shoulder against which a small coil spring 8 can be seated by the ball as shown on the right side of FIG. 2. The coil spring has several convolutions and normally lies flat in the position shown to the left in FIG. 2 when the valve is open.

On the other hand, when a vacuum is drawn upon the bore 2 through the manifold 5 and the bore portion 4, the ball 6 serves as a piston which moves toward the conical shoulder and thereby compresses the spring 8 until it lies thereagainst, as shown to the right in FIG. 2. This position is referred to as the closed position of the valve assembly although as a matter of fact the bore which the ball controls is never completely closed as will be hereinafter explained.

Referring again to the structure shown in FIG. 1, the suction points comprising the bores 2, 3, and 4 are arranged in a pattern which covers most of the front face 1a of the panel 1 and which includes a series of openings arranged along mutually perpendicular coordinates disposed parallel to the edges of the panel.

FIG. 3 shows a vacuum board similar to that of FIG. 1 but with the entire front panel omitted so as to expose a serpentine system of channels in which the vacuum is first drawn on the center of the board, and then progresses outwardly toward the peripheral board areas. The illustrated modification includes a rear panel member 20 having a plurality of ribs 21 attached thereto to form, when assembled with the front panel member (not shown), channels which are about one-eighth of an inch deep and several inches or more wide. The novelty resides in the serpentine lay-out of channels rather than in their details of structure. For instance, the ribs could be attached to the rear of a front panel member if desired. In this arrangement, there is a diagonal entrance channel 22 which directly couples a vacuum conduit C' to the labyrinth channel at its center S which channel then folds around the center of the board to form one continuous passage, having no branches or parallel courses, and ending at E. The suction holes on the front panel are disposed to fall into a channel, and do not lie opposite any of the rib areas 21.

Operation

The reasons for the novel structures of the present disclosure will become apparent 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, but since in most installations it is desirable to use only a relatively small vacuum pump P, the closure valves shown in the bores become desirable 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. By inspection of FIGS. 1 and 3, it will be seen that the vacuum manifolds comprise serpentine channels which are relatively small in cross-sectional areas. In practical working embodiments of the present invention, the channels 5 are milled into or built up upon one of the panel members only to a depth of about one-eighth of an inch, and the width of each channel is about five inches. Since the channels are of relatively small cross-sectional area, when the vacuum pump P is first started the end of the channel connected to the conduit C or C' drops in pressure considerably ahead of the time that the pressure begins dropping in the more remotely located channel portions, and since the channels are so shallow, the air being evacuated is forced to jet past the inner ends of the bores thus providing a dust scavenging action as well as an air eductor action. Thus, even a small pump P, such as a domestic vacuum cleaner, can commence closing the valves located in the starting portions of the channels without having to immediately evacuate the entire manifold volume. Hence, when the pump P is started, the valves close first in the starting points of the channels, and then successively close in a sequence winding around the center of the panel and approaching the outer restricted or closed end of the channel.

In a practical board assembly it may be desirable to employ several serpentine manifolds located behind the main panel member and together comprising the overall manifold means.

Referring now to FIG. 2, this figure illustrates a valve structure having practical features. Experience has shown that the presence of dust in most valve structures is very damaging to their operation, and eventually renders the device inoperative. The principal advantage of the present structure is that the valve is self-cleaning since it is the convolutions of the coil spring 8 which form the valve element. In order to fully understand this action, it is desirable to assign dimensions to the embodiment shown in FIG. 2. Assume that the bore 4 is drilled by a number 30 twist drill and is therefore .128 inch in diameter. Further assume that the central bore 2 is a little more than $\frac{3}{16}$ in diameter, for example, .189 inch, the size of a number 12 drill. The ball 6 is $\frac{3}{16}$ in diameter or .187 inch, and the hole 7a in the washer 7 is the same diameter as the bore 4. The spring wire is about 6 thousandths in diameter and is wound so that when this spring spiral is squashed against the conical shoulder as shown in FIG. 2, there will be about 4 thousandths of an inch between convolutions.

As the ball 6 and the spring 8 are moved back and forth between the two different positions shown in FIG. 2, the relative motion between the spring convolutions will work through any dust which can pass through the bore hole 7a from outside the front panel member 1 into the channel 5. When the valve is in closed position small bleeding action results from the fact that the spring convolutions never precisely mate with each other to form a complete seal.

The outer surface 7b 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 7a. Some prior patents have shown other types of roughening of the outer surface in the vicinity of each vacuum hole, but many of these structures require expensive concentric-groove machining of the front plate itself. The present invention is believed to constitute an improvement by

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requiring only inexpensive knurling of the washers themselves before they are installed in the bore portions 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 sheets of photographic apparatus, comprising:

(a) a front panel member having a pattern of suction holes therethrough;

(b) vacuum-operated valve means in each hole for closing the latter when the hole is not covered by a sheet;

(c) manifold means behind the front panel member and comprising multiple channels disposed against said member in communication with said holes, the channels being mutually connected together in series to form one continuous passageway, one end of the series being closed and the other end having an evacuation outlet, the channels being shallow as compared with their width, and their width being small as compared with an edge length of the vacuum board.

2. In a vacuum board as set forth in claim 1, said channels being folded around each other from the outer periphery of the vacuum board into its central area to provide a serpentine path of substantially-constant cross-sectional area.

3. In a vacuum board as set forth in claim 1, said channels including an entrance channel extending from said outlet at one corner of the vacuum board to its center, and including serpentine channels folded back and forth around the center and terminating in the vicinity of an edge of the vacuum board, the channels being substantially constant in cross-sectional area.

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4. A vacuum board for holding photographic sheets of various sizes, comprising:

(a) a panel member having a large number of suction holes therethrough disposed close together;

(b) vacuum-operated valve means in each hole for automatically closing that hole when it is uncovered by a sheet;

(c) vacuum manifold means adjacent the panel member and comprising multiple channels disposed in communication with said holes, the channels being mutually connected together to form a continuous series including at one end an evacuation channel extending from a central area of the board to a vacuum coupling near one edge of the board, the remaining channels being arranged in a serpentine pattern starting in said central area and folded back and forth around that area and reversing on each side of the evacuation channel, and said remaining channels terminating in a closed end located near an outer edge of the board.

5. In a vacuum board as set forth in claim 4, the depth of the channels as measured normal to said panel member being no greater than 10% of their width, and the cross-sectional area of each channel being no greater than the area of the vacuum coupling.

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