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INCLINED-BORE VACUUM BOARD VALVE

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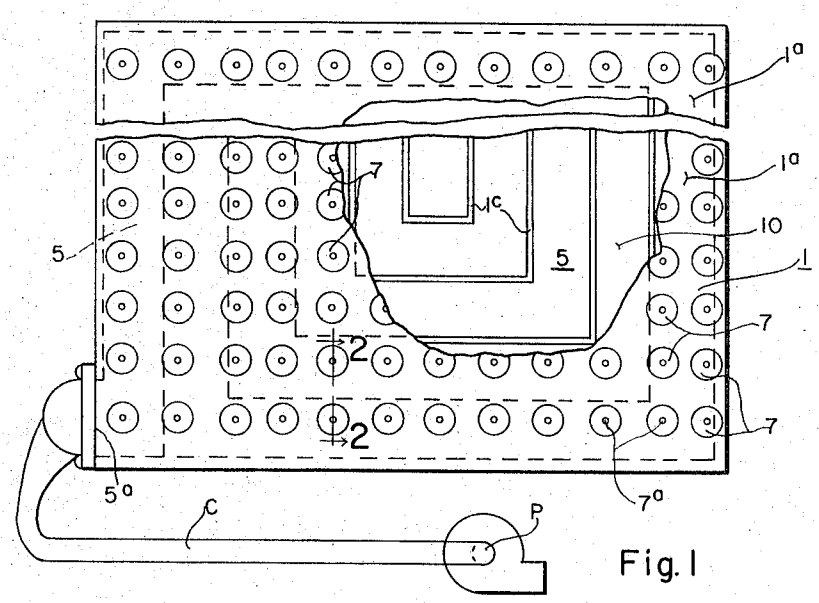


Fig. 1

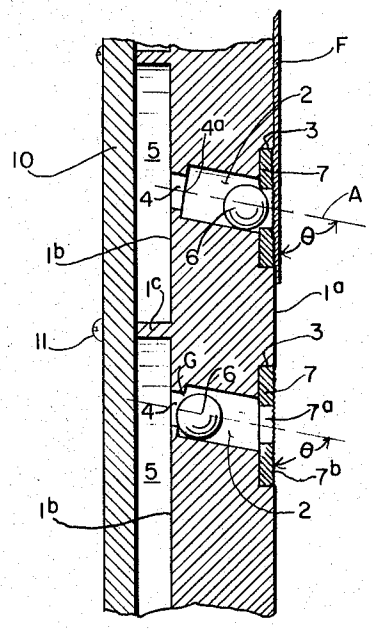


Fig. 2

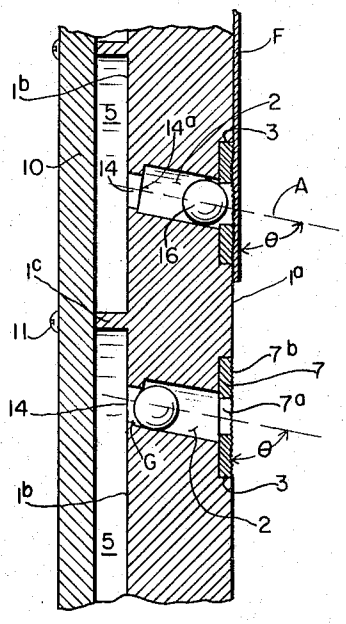


Fig. 3

INVENTOR

JOE MICHAEL COCITO

BY Alexander & Dowell

ATTORNEYS

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INCLINED-BORE VACUUM BOARD VALVE

Joe Michael Cocito, 11008 Nicholas Drive, Wheaton, Md. 20902

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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 an improved valve means for automatically reducing the flow of air into vacum holes which are not covered by a particular 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 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 Patens 2,910,265, 2,753,574, 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.

This 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 ball sized to be a loose sliding-fit in a bore having a shoulder therein. The parts are shaped so that when the vacuum pulls the ball against the shoulder, the ball cannot possibly seat tightly, thereby leaving a small leakage space. This structure provides the desired valving action, without however, completely closing the bore to the flow of air. Such leakage assures that when the outer end of the bore is closed by a film laid thereover, the air between the ball and the film will leak into the manifold by passing through the imperfect seating zone where the ball attempts to seat against the shoulder, and thus release the air pressure holding the ball against the shoulder to open the valve. The bore containing the valve ball is inclined away from the shoulder so that when air is cut off so that it no longer holds the ball thereagainst, the ball rolls down the bore away therefrom. 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. The present 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 line 2—2 of FIG. 1, this figure showing the upper ball valve in open position and the lower ball valve in closed position; and

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

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 **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 and 3.

The manner in which the present 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 nonporous webs overlying the front face **1***a* of the panel **1**. In the present disclosure the valve means by which the closing of the uncovered bores is accomplished includes a ball **6**, located in each of the major bores **2** and fitting it

fairly snugly, but with some clearance. The ball **6** is kept in the bore **2** by a retainer washer **7** having a hole **7***a* therethrough and having a knurled front face **7***b*. The front panel **1** stands vertical, but the walls of the bores **4** in FIG. 2, and **14** in FIG. 3, are inclined at an angle θ so that gravity urges the ball **6** to roll away from the shoulder toward the ball-retaining washer **7** which is a press-fit in the bore portion **3**. The rear bore portion **4** is smaller in diameter than the central bore portion **2** so as to form a shoulder **4***a* against which the ball can seat, but imperfectly. In the embodiment shown in FIG. 2, the shoulder **4***a* is concentric with the axis A of the bore **2**, but in the modification shown in FIG. 3 the smaller bore **14** is centered below the axis A and also show a line drawn through the center of the ball **6** parallel to the axis A.

When a vacuum is drawn upon the bore **2** through the manifold **5** and the bore portion **4**, the ball **6** moves to the left and tries to seat against the shoulder **4***a* at the inner end of the bore **2**, as shown at the lower position in FIG. 2. When a heavy steel ball is used, the weight of the ball is too great to permit the modest amount of suction at the bore portion **4** to raise the ball upwardly from lying upon the wall of the bore **2** as shown in FIG. 2 to a full seated position against the shoulder **4***a*.

FIG. 3 shows a modified form of the invention in which structure which is similar to that shown in FIG. 2 is provided with the same reference numeral. The difference resides in the offset location of the inner bore portion **14** with respect to the axis A, and in the weight of the ball **16** as compared with the ball **6**. As stated above, in FIG. 2 the ball **6** cannot seat fully against the shoulder **4***a* because it is too heavy to lift from the position shown in the lower half of FIG. 2 upwardly into a fully seated position, thereby leaving the gap G between the ball and the shoulder as shown in FIG. 2.

In FIG. 3, the ball **16** must also be prevented from seating perfectly against the shoulder **14***a*. Although a light-weight ball **6** would not work properly in the FIG. 2 structure, either a light or heavy ball **16** will work well in the FIG. 3 structure. In the latter case, the bore **14** has been offset with its axis lying below the axis A of the bore portion **2** and also below the center of the ball **16**. Thus, when vacuum attracts the ball **16** against the shoulder **14***a*, it touches only the upper periphery thereof, but cannot seat against the lower periphery, whereby a gap at G' always remains between the ball **16** and the shoulder **14***a*.

Operation

The reasons for the novel structure 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 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 channels **5** are milled into or built up upon one of the panel members **1** or **10** 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 and 3, 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 valve has only one moving part, a smooth ball, which does not tend to entrap or hold dust. The ball has several thousandths of an inch clearance with the bore **2**, and the latter is long enough axially to let the ball rotate through considerable angles as it rolls in the bore **2**, thereby encouraging air jetting past the ball to flush out the clearance space. In order to fully explain this cleaning action, it is desirable to assign dimensions to the structure shown in FIGS. 2 and 3. Assume that the bore **4**, or the bore **14** is drilled by a number 30 twist drill and is therefore about .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**, or the ball **16**, is $\frac{3}{16}$ in diameter, or .187 inch, and the hole **7***a* in the washer **7** is the same diameter as the bore **4**. As long as the ball **6** or **16** is in open position the bores **4** and **7***a* and the clearance past the ball determine how much air can pass through the bore hole from outside the front panel member **1** into the channel **5**. However, when the ball valve is in closed position as shown in the lower halves of FIGS. 2 and 3, the air which seeks to pass leftwardly through the suction hole is further restricted by the smallness of the gap G or G' through which the escaping air must travel to reach the manifold **5**. On the other hand, when the ball rolls to the right against the washer **7**, the dust can easily escape through the bore **4**, or **14**, which is then opened wide. The escape tends to occur on a subsequent cycle of the valving action, the dust being swept along by the air jetting through the clearance between the ball and the bore **2** as the ball is sucked up toward the shoulder. This structure therefore provides a small leaking gap between the ball and the shoulder when the valve is in closed position, but a much larger gap there when the valve is in open position.

The structure shown in FIG. 2 is cheaper to manufacture because the bore portions **2** and **4** are concentric and can therefore be bored by a single stroke of a stepped drill bit. However, the modified structure of FIG. 3 has the advantage of a better dust flushing action for two reasons. First, the gap G' is at the bottom of the shoulder **14***a* so that the continuous jetting action of air through the gap G' will occur at the bottom of the shoulder where dust is more likely to collect. Therefore, even when the valve ball **16** is in closed position, the dust will tend to flush through better than will occur in FIG. 2 where the gap G is at the top of the shoulder. Secondly, the shoulder represents a much smaller step at its bottom in FIG. 3 than at its bottom in FIG. 2, thereby making a much smaller step in bore diameter against which to collect dust. FIG. 3 also has the advantage that it is impossible for the ball **16** to seat against the shoulder **14***a* perfectly, whereas it is perhaps possible in the presence of an unexpectedly great vacuum for the ball **6** in FIG. 2 to seat fully against the shoulder **4***a*.

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 an 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 least one portion of the bore located between the shoulder and the front face having its walls inclined downwardly toward the latter when the panel member is upright;

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

(c) vacuum-operated valve means in each suction hole and comprising a ball which is a free rolling-fit in said one portion of the bore

(d) each shoulder having an opening therethrough which is smaller than the diameter of the ball and which communicates with another portion of the bore which extends through the rear of the panel member, the center of the opening through the shoulder being more than one radius of the ball from the nearest wall surface of said one portion of the bore near the shoulder, and the ball being weighted beyond the capability of the vacuum in the manifold means to lift it into fully seated position in the opening at the shoulder; and

(e) means near the front-face for retaining the balls in the bores.

2. In a vacuum board as set forth in claim 1, said bore having an enlargement where it meets the front face of the panel member, and said retaining means comprising a washer pressed into said enlargement and having a roughened outer surface flush with said front face.

3. In a vacuum board as set forth in claim 1, said one bore portion being substantially cylindrical.

4. 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 least one portion of the bore located between the shoulder and the front face having its walls inclined downwardly toward the latter when the panel member is upright;

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

(c) vacuum-operated valve means in each suction hole and comprising a ball which is a free rolling-fit in said one portion of the bore;

(d) each shoulder having an opening therethrough which is smaller than the diameter of the ball and which communicates with another portion of the bore which extends through the rear of the panel member, the center of the opening through the shoulder being less than one radius of the ball from the nearest wall surface of said one portion of the bore, whereby it is impossible for the ball to fully seat against the shoulder at said opening; and

(e) means near the front-face for retaining the balls in the bores.

5. In a vacuum board as set forth in claim 4, the center of the opening through the shoulder being less than one radius of the ball distance from the lowermost wall surface of said one portion of the bore near the shoulder and directly thereabove.

6. In a vacuum board as set forth in claim 4, said bore having an enlargement where it meets the front face of the panel member, and said retaining means comprising means secured in said enlargement and having a hole through it to admit air into the bore.

7. In a vacuum board as set forth in claim 6, said secured means comprising a washer having a roughened outer surface disposed flush with said front face.

8. In a vacuum board as set forth in claim 4, said one portion of the bore being substantially cylindrical.

9. In a vacuum board as set forth in claim 4, the length of said one portion of the bore between the retaining means and the shoulder being at least half-again greater than the diameter of the ball.

References Cited by the Examiner

UNITED STATES PATENTS

2,731,299	1/1956	Bramming	137—513.5 X
2,782,574	2/1957	Copold	269—21 X
3,197,170	7/1965	Schutt et al.	248—363

FOREIGN PATENTS

95,562	2/1960	Norway.

CLAUDE A. LE ROY, *Primary Examiner.*

R. P. SEITTER, *Assistant Examiner.*