

Oct. 22, 1968

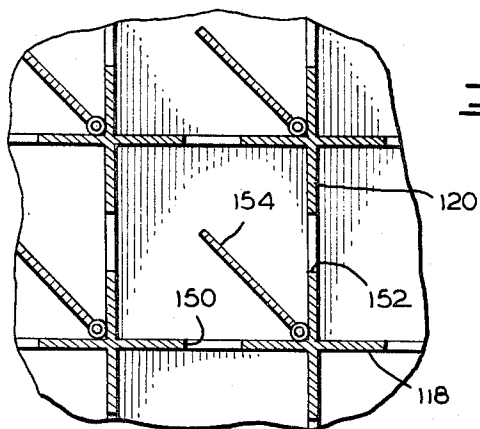
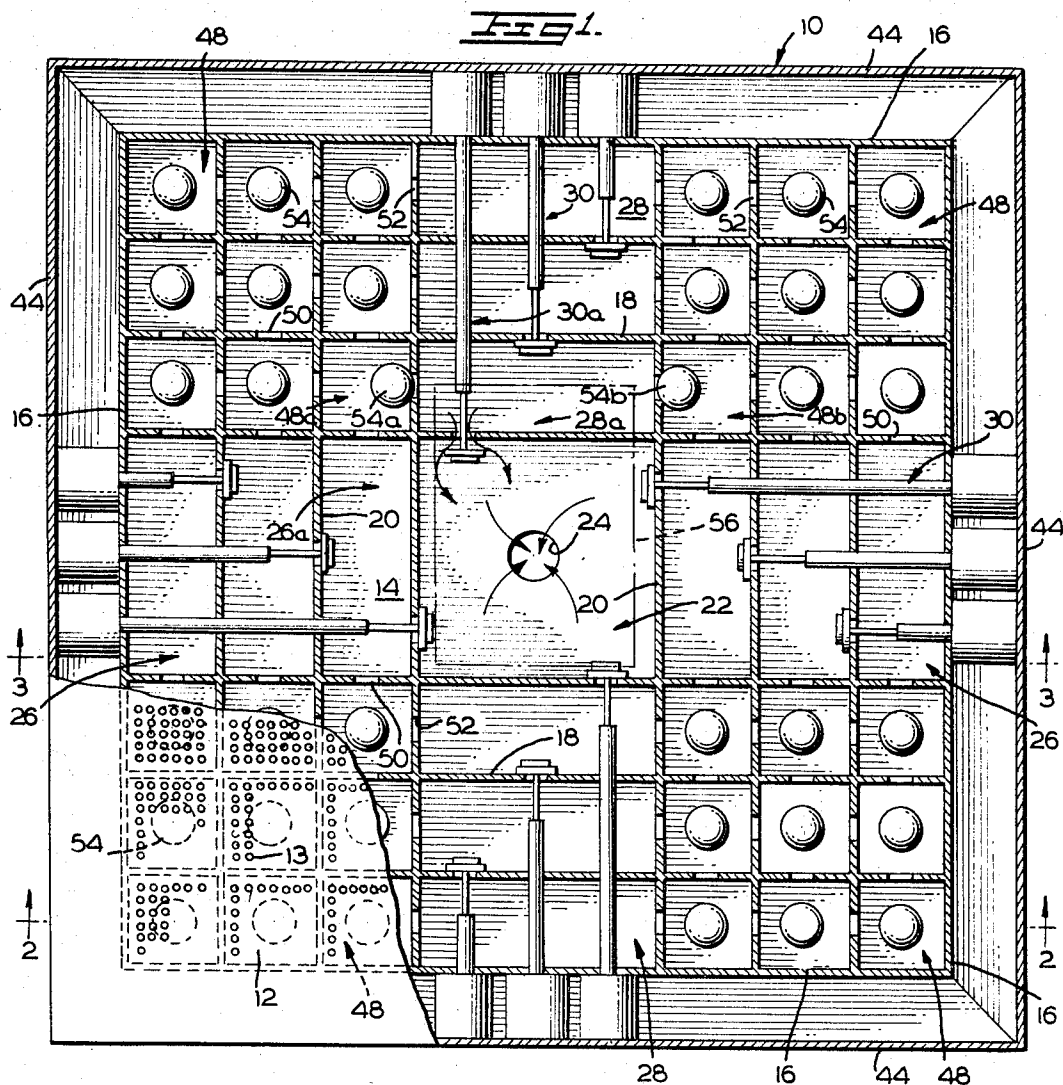
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3,406,938

VACUUM HOLDER

Filed July 5, 1966

3 Sheets-Sheet 1



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FIG. 2.

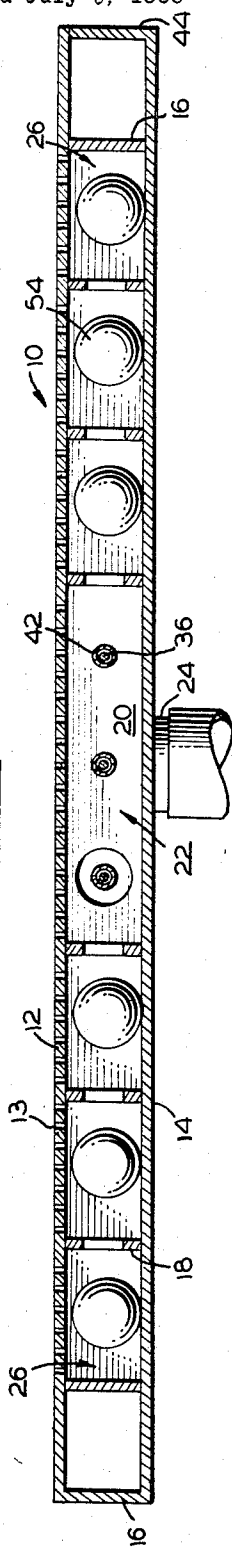


FIG. 3.

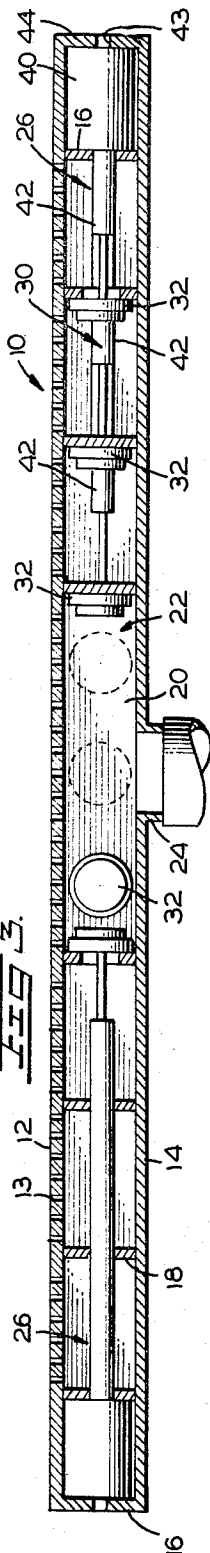
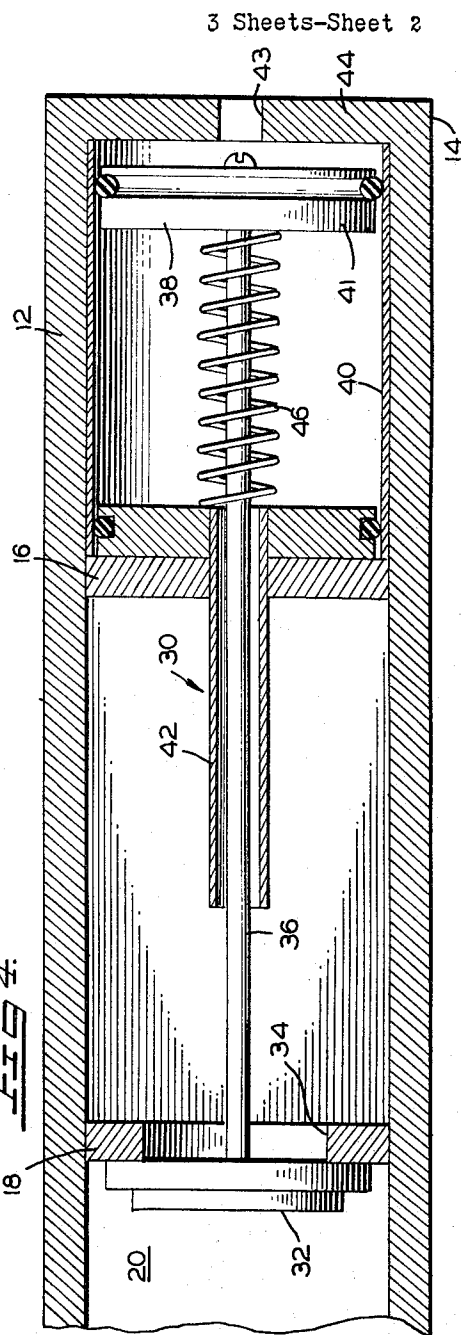


FIG. 4.



3 Sheets-Sheet 2

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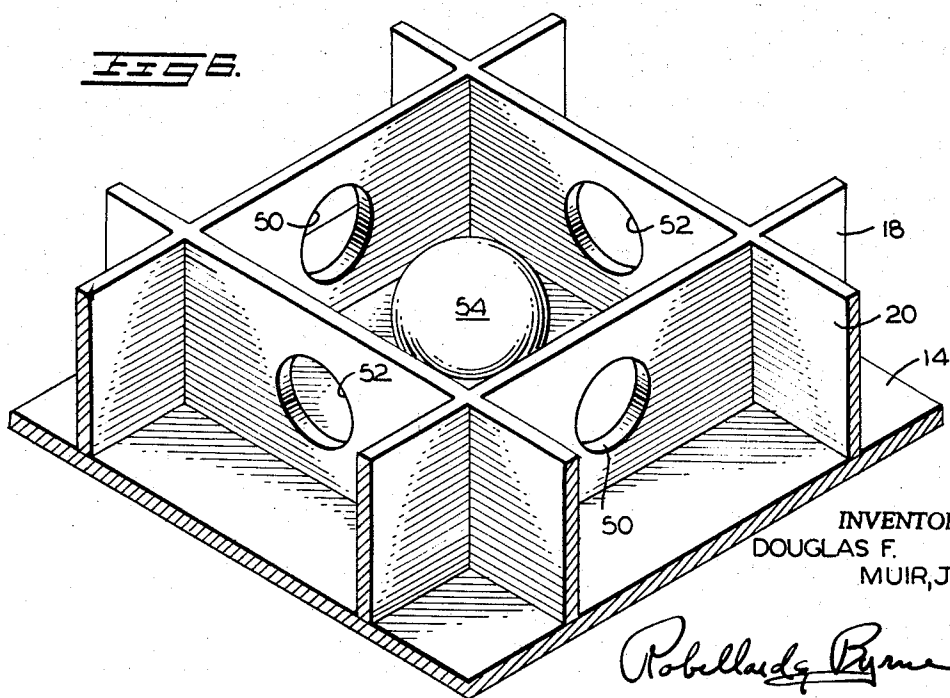
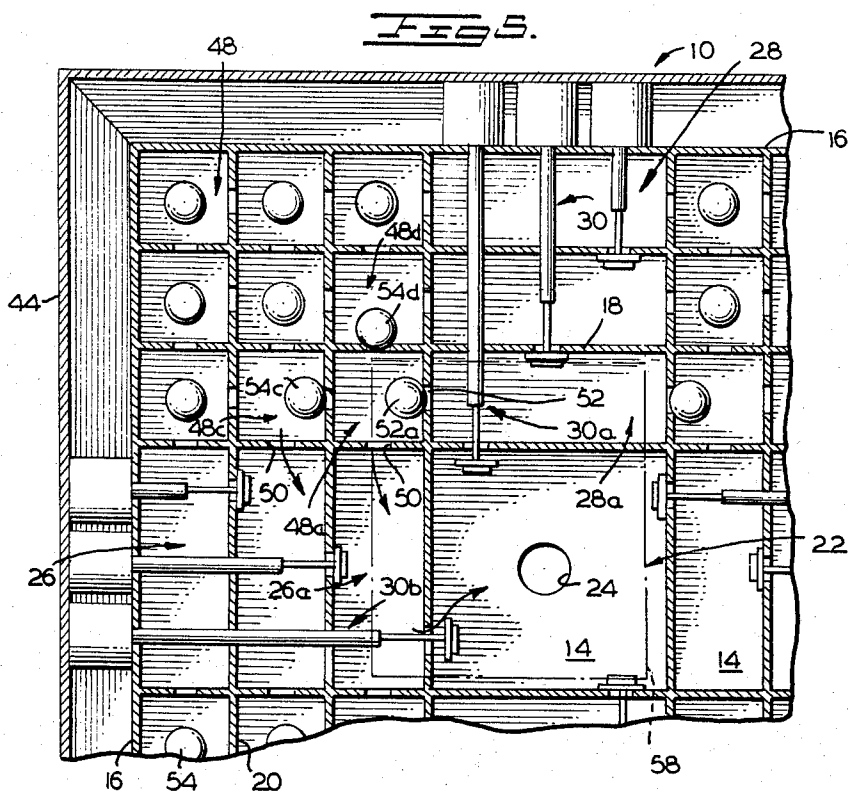
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VACUUM HOLDER

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3 Sheets-Sheet 3



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VACUUM HOLDER

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Continuation-in-part of application Ser. No. 503,354,
Oct. 23, 1965. This application July 5, 1966, Ser.
No. 562,592

4 Claims. (Cl. 248—363)

ABSTRACT OF THE DISCLOSURE

A vacuum holder having a pervious holding surface communicating with a chamber divided into a network of independent subchambers by a plurality of intersecting walls, and a source of vacuum communicating with one of the subchambers. The subchambers aligned with the one subchamber in two directions constitute primary subchambers and valves are disposed in the common walls thereof to control communication between the primary subchambers adjacent the one subchamber and the one subchamber and between each of the succeeding primary subchambers. The remaining subchambers constitute secondary subchambers with two walls thereof each aligned with a primary subchamber. The two walls are provided with openings and movable valve members disposed in the secondary subchamber, selectively block communication through one of the openings.

This application is a continuation-in-part of my copending application Ser. No. 503,354, filed Oct. 23, 1965.

This invention relates generally to work holders, grippers and the like and more particularly to a vacuum-operated work holder and article gripper.

As described in applicant's Patent No. 3,229,953, issued Jan. 18, 1966, there are many devices known in the art for gripping articles to lift, move, hold or otherwise handle the items for performing various operations thereon. Among the prior art devices, those which function by operation of vacuum are in increasing use.

Vacuum-operated devices of the above type are particularly useful for holding sheets of material in a flat planar configuration and for this reason they have found wide use in photographic, graphic arts and other industries.

As was more fully described in applicant's copending application Ser. No. 503,354, filed Oct. 23, 1965, one of the problems with the prior art vacuum-operated devices, particularly when used for holding sheet material in photographic or graphic art processes, is that the prior art vacuum holders have not been particularly efficient in handling odd-size material such as film strips or other narrow sheets.

In the above-mentioned copending application, a structure is disclosed which avoids the prior problems of handling odd-size sheet material. This structure includes a vacuum holder having a chamber subdivided into a "checkerboard" or side-by-side pattern of subchambers by a plurality of intersecting walls so that vacuum may be applied to the mounting surface of the holder in any required pattern as dictated by the shape of the sheet material to be held. As has also been described in the above-mentioned copending application, this type of structure requires individual valving for each of the subchambers. The valving for a portion of or the secondary subchambers is accomplished by means of a series of sliding valves operated by a valve-actuator which is driven by the pressure differential between the secondary subchamber and a corresponding primary subchamber to open the slide valves.

The primary disadvantage of the above-disclosed struc-

ture is that a large number of secondary valves are required and a high degree of accuracy is necessitated in the positioning of slide rods through the walls defining the subchambers. The above requirements increase the complexity, time and cost of fabrication of the holder above that of the more conventional board.

It is, therefore, an object of this invention to provide a vacuum holder of the type described which avoids the difficulties of the prior art holder by providing a novel valving structure for the secondary subchambers thereof.

It is another object of this invention to provide a vacuum holder having a series of independent, "checkerboard" type subchambers therein in which the subchambers are simply and inexpensively valved by furnishing a novel valve structure which effectively valves each of the subchambers in an independent fashion.

In a preferred embodiment, the objects of this invention are achieved by providing a vacuum holding device comprising a pervious holding surface; a chamber communicating with the pervious holding surface; intersecting walls dividing the chamber into a network of independent subchambers; a source of vacuum connected to one of the subchambers; the subchambers aligned in two directions with the one subchamber constituting primary subchambers and having valves disposed in the common walls thereof to selectively control communication between the primary subchambers adjacent the one subchamber and the one subchamber and between the adjacent primary subchambers and the succeeding primary subchambers thereto; the remaining subchambers constituting secondary subchambers with the two walls thereof most proximate said primary subchambers each aligned with a primary subchamber and having an opening in each of the two walls; and a movable valve member in each secondary subchamber to selectively block communication through one of the openings.

These and other objects of the invention will become more readily understood to those skilled in the art by reference to the following detailed description when viewed in light of the accompanying drawings wherein like numerals indicate like components throughout the figures thereof and wherein:

FIGURE 1 is a plan view of a holder in accordance with the invention with the upper surface thereof partly broken away;

FIGURE 2 is a sectional view of the holder of FIGURE 1 taken along the lines 2—2 thereof;

FIGURE 3 is a sectional view of the holder of FIGURE 1 taken along the lines 3—3 thereof;

FIGURE 4 is an enlarged fragmentary view of a portion of the holder of FIGURE 1 in sectional elevation;

FIGURE 5 is a fragmentary view of the holder of FIGURE 1 showing the holder in another phase of operation;

FIGURE 6 is an enlarged fragmentary perspective view of a subchamber of the holder of FIGURE 1 showing the valving of the secondary subchambers in detail; and

FIGURE 7 is a fragmentary plan view of a secondary subchamber in accordance with the invention showing another variation in the valving thereof.

Turning now to FIGURES 1, 2 and 3, a vacuum holder, indicated generally at 10, made up of a front or holding surface 12, perforated with a plurality of orifices 13, a back wall 14 and side walls 16 define a chamber behind the holding surface 12. The chamber is divided by a plurality of transverse and longitudinal inner walls 18 and 20 disposed to intersect within the chamber and divide it into a plurality of subchambers.

A source of vacuum (not shown) is connected to a centrally located subchamber, shown generally at 22, through a connection 24 in the back wall 14. Obviously commu-

nication with the subchamber 22 may be accomplished by conduiting to the side of the board or in the manner required if so desired. It should also be noted that the subchamber to which the vacuum source is connected may be located other than centrally if the use requirements of the holder so dictate.

Extending longitudinally and transversely from the central subchamber 22 are a series of subchambers, designated herein as transverse and longitudinal primary subchambers shown generally at 26 and 28 respectively. Each of these primary subchambers is provided with a primary valving device, shown generally at 30 which operates in an identical fashion to the valve disclosed in applicant's above-mentioned patent. Subchambers and valving therefore referred to specifically hereinafter will be indicated by alphabetical letters following the numbers.

Referring specifically to FIGURE 4, the valving device 30 is shown in enlarged detail and comprises a valving member 32 covering a valve orifice 34 through an inner wall and connected to a valve follower 36. The valve follower is connected, on the opposite end thereof, to a valve follower piston 38 which is slidably disposed in a valve follower cylinder 40. An O ring 40 provides a sliding seal between the piston 38 and cylinder 40. The valve follower cylinder is ported to the chamber to which the valve provides communication through a tube 42 disposed coaxially around the valve follower 36 and, on the opposite side of the piston to the atmosphere through a bore 43 through an outer wall 44 enclosing the valve follower cylinders 40. A compression spring 46, is coaxially mounted around the valve follower 36 and abuts the piston 38 to bias the valve member 32 in a closed position. The operation of the valving device, described in more detail in the applicant's aforementioned patent is briefly as follows: As the number of vacuum orifices 13 in the holding surface 12 communicating with the chamber to which the valve provides communication, are further covered by articles of increasing size, the pressure in that chamber is lowered through the action of the vacuum source so that an increasing pressure differential is generated between the chamber to which the valve provides communication and the preceding chamber (toward the centrally located subchamber 22) thereto. When this pressure differential reaches a value great enough to initially overcome the bias of the spring 46, the valving member 32 is drawn away from the valve orifice 34 thereby opening the valve and applying vacuum to the orifices which communicate with the chamber to which the valve provides communication. With this valving member movement, the valve follower 36 and piston 38 also move, with the valving member. As objects of increasing size are applied to the face of the holder, the action of the pump pulling air through the valve orifice 34 continues to decrease the pressure in the chamber being overlapped thereby increasing the pressure differential between the atmosphere and that chamber.

When the differential between chamber pressure and ambient atmospheric pressure reaches a value which is large enough to fully overcome the biasing forces of the spring 46, the ambient pressure acts against the back of the piston 38 to hold the valve open independently of the pressure difference between the aforementioned chambers. Through the above-described process, the succeeding primary longitudinal and transverse subchambers 26 and 28 are opened when sheet material of increasing size imposed on the holding surface 12.

Returning now specifically to FIGURE 1 of the drawings, the remaining subchambers in the areas between the arms defined by the primary subchambers 26 and 28 are designated secondary subchambers shown generally at 48. The intersecting inner walls 18 and 20 forming these subchambers are provided with openings 50 and 52, respectively, so disposed that the walls defining each of the secondary subchambers 48 having openings therethrough to provide communication with each of the subchambers

adjacent thereto. A secondary subchamber valving member 54 in the form of a lightweight sphere is disposed in each of the secondary subchambers 48. The valving member 54 may be made of cork, styrofoam, lightweight plastic or other suitable material or may be formed as a hollow sphere in the manner of a ping pong ball or the like as desired. The primary requisite of the ball is that it be sufficiently light enough to react to air flowing through the openings 50 or 52 from the subchambers as will be explained below. For example, in a subchamber having the following dimensions: 2 inches by 2 inches by 1½ inches and communicating with a source of vacuum having a rating of 30 inches of water lift, a ball 1 inch in diameter and weighing 0.5 gram is suitable to cooperate with openings 50 and 52½ inches in diameter for the purposes of this invention.

In operation, and referring specifically to FIGURE 1, the source of vacuum (not shown) is activated and air is withdrawn from the central subchamber 22 through the opening 24. When a sheet of material of the size shown in phantom at 56 is disposed on the holding surface 12 of the holder 10, the primary subchamber valve 30a is actuated as described above and as shown in that figure so that communication is provided between the central subchamber 22 and the primary subchamber 28a. In this configuration, air will also be withdrawn through the secondary subchambers 48a and 48b through the openings 52 thereof most proximate the primary subchamber 28a and, initially, through the succeeding secondary subchambers thereto. The air withdrawn from the secondary subchambers 48a and 48b flows through the aforementioned openings 52 thereby drawing the valving members 54a and 54b into those openings to block further flow there-through, thereby blocking application of the vacuum through the holding surface 12 to any larger area than that required for holding the sheet of material 56.

Referring now to FIGURE 5, a larger sheet of material, shown in phantom at 58, covers a portion of the secondary subchamber 48a and the primary subchamber 26a. When vacuum is applied to the holder, both of the primary subchamber valves 30a and 30b are actuated thereby providing communication between the central subchamber 22 and the primary secondary subchambers 26a and 28a. In this case air is withdrawn, as shown by arrows, through the orifices 50 and 52 between the secondary subchamber 48a and the primary subchambers 26a and 28a respectively. In this vacuum configuration the valving member 54a will be drawn toward both of the openings 50 and 52 and, depending on the relative magnitude of the airflow therethrough, can block only one of these openings (in the case illustrated 52) thereby allowing vacuum to be applied to the secondary subchamber 48a (through the opening 50). Vacuum applied to that secondary subchamber will also be applied initially to the secondary subchambers 48c and 48d through the openings providing communication therebetween thereby drawing the valving members 54c and 54d of the latter-mentioned subchambers into the openings 52 and 50 respectively providing communication thereto to block further flow from these subchambers. The above configuration will thereby apply the required vacuum distribution to the enlarged sheet 58 but prevent application of vacuum to areas larger than required.

From the above, it should be obvious that with increasing size sheets, the secondary subchambers will be similarly valved in succession to provide the proper pattern of vacuum application to and including the outermost subchambers of the holding device.

It should be obvious that valving members other than spheres can be used if desired or required. For example, referring to FIGURE 7, a "flag" type of valving device 154 can be used instead of the sphere of FIGURE 1. In FIGURE 7 components corresponding to those of the preceding figures are indicated by the same number only of the next higher order. The valving member 154 may

5

be pivotally mounted and lightly spring loaded to normally assume the neutral position shown in that figure or may be made of a light spring material and fixed in the corner formed by the intersecting walls 120 and 118. The spring loading should be only such value to maintain the member 154 in a neutral position when there is no airflow so that upon sufficient flow of air through either the opening 150 or 152, the member 154 may be displaced to block further flow therethrough.

What has been set forth above is intended primarily as exemplary to enable those skilled in the art in the practice of the teachings of this invention. It should, therefore, be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described.

What is new and, therefore, desired to be protected by Letters Patent of the United States is:

1. In a vacuum holding device having a pervious holding surface and a chamber communicating therewith, the chamber being divided into a network of independent subchambers by intersecting walls, a source of vacuum communicative with at least one of the subchambers, the subchambers aligned with the one subchamber in at least two directions constituting primary subchambers with a first valve means to control communication between the one subchamber and each of the primary subchambers adjacent thereto and between the adjacent primary subchambers and each of the succeeding primary subchambers thereto, the remaining subchambers constituting secondary subchambers having the two sides thereof proximate the primary subchambers each aligned with a primary subchamber, the improvement comprising:

second valve means controlling communication between each of the secondary subchambers adjacent said pri-

6

mary subchambers and said primary subchambers and between the adjacent secondary subchambers and each succeeding secondary subchamber thereto comprising:

an opening in each of said two walls and a second valve means in each of said secondary subchambers movable to each of said openings to block communication through one of said openings.

2. A valve in accordance with claim 1 wherein said second valve means comprises a sphere greater in diameter than that of said openings and freely movable within the subchamber in which it is disposed.

3. A valve in accordance with claim 1 wherein said second valve means comprises a structure pivotally mounted between said two opening to be swingable into positions blocking airflow through either one thereof and normally biased in a position out of blocking position with respect thereto.

4. A vacuum holder in accordance with claim 1 wherein said primary subchambers are arranged in transverse and longitudinally aligned directions with respect to said one subchamber; and

said secondary subchambers are each aligned in a transverse and a longitudinal direction with a transverse and a longitudinally aligned primary subchamber.

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