April 13, 1965 C. B. MOORE 3,177,888

CONTROL APPARATUS

Filed Sept. 21, 1962

FIG. 1

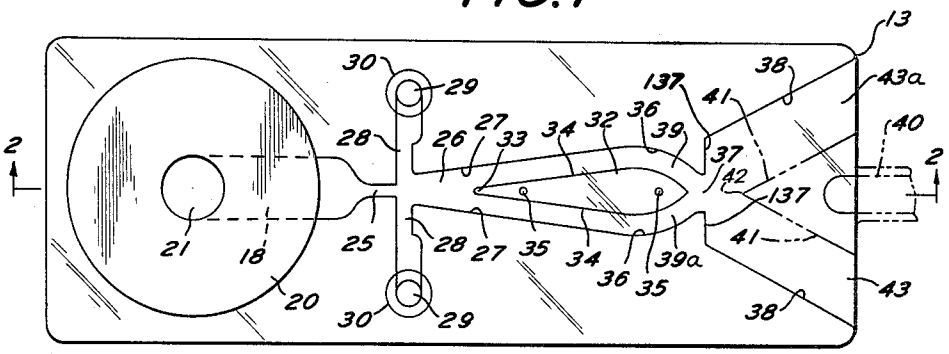


FIG. 2

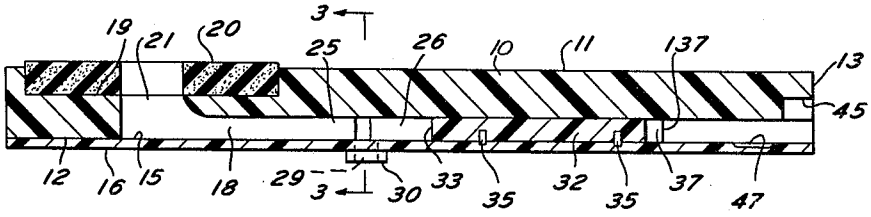


FIG. 3

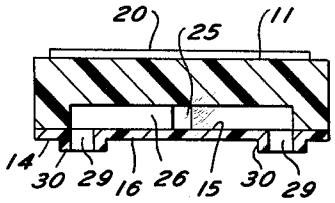


FIG. 5

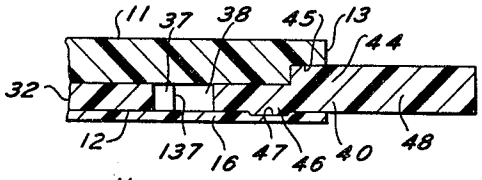


FIG. 6

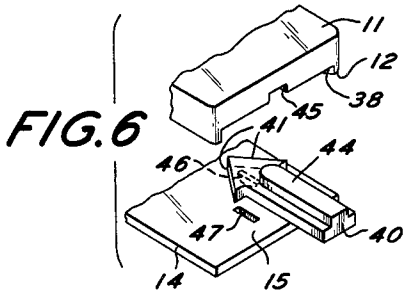
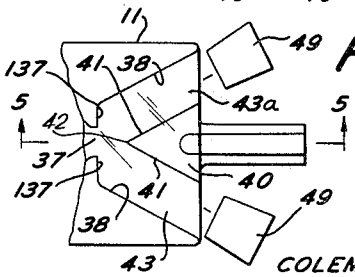


FIG. 4



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3,177,888

CONTROL APPARATUS

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12 Claims. (Cl. 137—81.5)

This invention relates to control apparatus and more particularly to fluid interaction jet control apparatus.

It is the principal object of the present invention to provide apparatus for controlling the positioning of a jet in which a throttling action and an on-off action can be obtained as desired.

It is a further object of the present invention to provide apparatus for controlling the positioning of a jet by pure fluid interaction in which both throttling action and memory are combined in the same unit.

It is a further object of the present invention to provide apparatus for controlling the positioning of a jet by pure fluid interaction in which the structure can be utilized for visually demonstrating the operation and which can be modified for demonstrating modified operations.

It is a further object of the present operation to provide flow control apparatus utilizing a jet, and controlling the positioning of the jet, the same being readily manually controllable.

Other objects and advantageous features of the invention will be apparent from the description and claims.

The nature and characteristic features of the invention will be more readily understood from the following description, taken in connection with the accompanying drawings forming part hereof, in which:

FIGURE 1 is a top plan view of one preferred embodiment of the invention, and with the rear divider removed;

FIG. 2 is a longitudinal vertical sectional view taken approximately on the line 2—2 of FIG. 1;

FIG. 3 is a vertical sectional view taken approximately on the line 3—3 of FIG. 2;

FIG. 4 is a fragmentary plan view of a portion of FIG. 1, with the rear divider in place;

FIG. 5 is a vertical sectional view taken approximately on the line 5—5 of FIG. 4; and

FIG. 6 is an exploded fragmentary perspective view showing one preferred mounting for the rear divider.

It should, of course, be understood that the description and drawings are illustrative merely and that various modifications and changes can be made in the structure disclosed without departing from the spirit of the invention.

Like numerals refer to like parts throughout the several views.

It has heretofore been proposed to control fluid flow by pure fluid interaction devices in which a jet discharges into an interaction chamber having opposite side walls symmetrical with respect to the longitudinal axis of the jet. For some purposes, also, a symmetrical divider was provided in the interaction chamber to separate spaced symmetrical discharge. In such devices, the jet stream striking the divider was split and deflected to the side walls, and formed regions on both sides of the jet stream delineated by the side walls and the jet stream. Each of these regions was provided with control connections contiguous to the entrance location of the jet for input or discharge, as determined by the relation of pressure conditions in the chamber to the ambient pressure. According to the prior art, the discharge passageways of these devices remained separate and did not cross each other as in the present invention.

The type of control obtained with the devices heretofore available was determined largely by the ratio of the longitudinal dimension between the nozzle and the

leading edge of the divider compared to the width or transverse dimension of the jet.

It has been found by prior investigators, under certain conditions, that when the ratio of this longitudinal dimension to this transverse dimension is less than five, it is possible to switch the flow of the jet smoothly from either side to the other side, and return, or to divide the flow in any desired proportion between the two discharge passageways. The transfer is accomplished by controlling the admission of fluid through the control connections.

In one common arrangement heretofore proposed, it was found that the jet induces, by aspiration, a vacuum or subatmospheric pressure between the side walls and the jet. If one of the control connections were to be closed, or partially restricted, while the other remained open, the aspirating action would reduce the pressure between the jet and the side wall on the restricted side more than on the other, causing a pressure differential to exist on the opposite sides of the jet streams, thus deflecting it toward the side with the restricted connection, and the amount of deflection would increase as the control connection approaches the closed condition when the differential is at its maximum.

If, other conditions remaining the same, the ratio of the longitudinal dimension to the transverse dimension identified above is increased to between about five and twelve, the jet tends to be bistable, i.e., it will follow either side wall but cannot be made to divide evenly between the two, no matter how the control connections are manipulated. The jet will snap suddenly from one side to the one on which the control connection is closed. If both control connections are closed the jet will remain locked to that side where the control connection was first closed. The jet may still be switched to the other side by blocking either of the discharge passageways.

If the leading edge of the divider is moved further from the entrance of the jet, so that the ratio of the longitudinal dimension to the transverse dimension is increased beyond about twelve, the jet can no longer be switched from one side wall to the other by obstructing the discharge passageways. The relation in which the flow pattern is not permanently influenced by temporary conditions downstream in the discharge passageways has been designated as "memory."

From this it will be seen that it was not heretofore considered possible, in a single device, to have the ability to control the flow smoothly between two outlets and at the same time provide memory. In the device of the present invention the shortcomings of the prior devices in this respect have been overcome.

Referring now more particularly to the drawings, a base **10** is provided, of generally rectangular shape with an upper face **11**, and a lower face **12** and with a rear or downstream end face **13**. The base **10** is preferably made of a transparent synthetic plastic material molded or otherwise formed to have the desired interior construction as hereinafter explained. The base **10** is in superposed and engaging relation to a closure plate **14**. The closure plate **14** has an upper face **15** and a lower face **16**. The base **10** and closure plate **14** are secured together in any desired manner, such as by a suitable adhesive (not shown) applied to one or both of the faces **12** and **15** prior to their engagement. The closure plate **14** is preferably also of transparent synthetic plastic material.

The base **10** has a fluid inlet passageway **18** formed therein and as one mode of providing access thereto the upper face **11** can have a recess **19** with a resilient gasket **20** mounted and secured therein for engagement by a faucet (not shown) or other supply of non-expansible fluid, such as water. The recess **19** has a central opening **21** communicating with the passageway **18**.

The body 10 has a nozzle 25 communicating with an interaction chamber 26 having opposite symmetrical diverging side wall portions 27. Immediately beyond the nozzle 25 in the chamber 26, opposite transversely and outwardly extending control fluid connections 28 are provided having fluid passageways 29 in the plate 14 extending thereto. The terminals of the passageways 29 at the plate 14 can have bosses 30 therearound to facilitate manual manipulation and control of flow through the passageways 29 and the fluid connections 28.

The chamber 26 is provided in the interior thereof with a central divider 32 having a leading edge 33 and opposite symmetrical side walls 34. The divider 32 can be retained in position in any desired manner such as by mounting pins 35 carried thereby and by the plate 14.

In accordance with the present invention the diverging side wall portions 27 have continuous therewith and extending therefrom converging side wall portions 36 which extend in intersecting relation toward a throat or passageway 37. The throat or passageway 37 is preferably of sufficient size to be non-choking and to give a good aspirating action. The passageway 37 can be modified in size to set up a pressure in the chamber 26 which is different in either sense from the ambient discharge pressure. From the passageway 37, opposite diverging walls 38 extend to the rear end face 13, preferably with setbacks 137 to avoid any tendency for the fluid to lock onto the walls 38.

The leading edge 33 of the divider 32 is located a suitable longitudinal distance with respect to the terminal of the nozzle 25 at the chamber 26 so that the ratio of the longitudinal distance to the width of the nozzle 25 is less than five.

It will be noted that the walls 34 of the divider 32 are spaced inwardly from the wall portions 27 and 36, thus providing intersecting passageways 39 and 39*a*, and the diverging walls 38 are substantially tangential with the rear portions of the walls 34.

While for certain purposes, as hereinbefore explained, the space between the diverging walls 38 to the rear of passageway 37 may be clear and open, it is preferred for other purposes that extensions be provided for the passageways 39 and 39*a* to complete the crossing.

In order to provide extensions for the passageways 39 and 39*a*, a rear divider 40 is provided having opposite side walls 41 meeting at a leading edge 42. The walls 41 are spaced inwardly from the diverging walls 38 to provide fluid discharge passageways 43 and 43*a*. The divider 40 can be provided with an upper longitudinally extending guide tongue 44 engageable in an upper guide groove 45 in the base 10, for locating the divider 40 in its proper sidewise relation, and a locking projection 46 engageable in a complemental locking recess 47 in the plate 14, for retaining the rear divider 40 at its proper location. The rear divider 40 can also have a rearwardly extending handle projection 48 for aiding the manual insertion or removal, as desired, of the rear divider 40.

Removable obstructing plugs 49 can be provided for selectively closing the passageways 43 and 43*a*.

The mode of operation will now be pointed out, assuming first that the rear divider 40 is in place.

Liquid is supplied to and through the opening 21 to the passageway 18 and is delivered through the nozzle 25 in the form of a jet. The jet from the nozzle 25 is divided by the leading edge 33 of the divider 32 and passes along each of the passageways 39 and 39*a*, and through the passageway 37 and then through the passageways 43 and 43*a* for discharge. Since, as previously pointed out, the ratio of the longitudinal distance from the nozzle 25 to the divider 33 is less than five, a smooth throttling action can be obtained. The flow can be gradually transferred between the passageways 39 and 39*a* and between the passageways 43 and 43*a* by manipulating, such as with the fingers, the areas of the openings 29.

The distribution in the passageways 39 and 39*a* is maintained in the passageways 43 and 43*a*. For example, if one of the openings 29 on FIG. 1 is closed more than the other, so that two-thirds of the fluid is flowing in the passageway 39 and one-third in the passageway 39*a*, by the laws governing momentum exchange the fluid will be redirected at the passageway 37 so that approximately two-thirds of the fluid will exit through the passageway 43 and one-third through the passageway 43*a*. In order for the structure to throttle smoothly it is necessary for both fluid inlets 29 to be partially opened. If either inlet 29 is closed the stream will flow entirely on the side where the inlet 29 is closed. If both inlets are closed the stream will continue to flow on that side which was closed first.

In addition to the throttling action and on-off action, the structure will have memory, as previously referred to. If, in the structure shown, the fluid jet has been deflected along one of the wall portions 27, so as to be flowing in the passageway 39, and both of the fluid inlets 29 are closed, the fluid will continue to flow, as before, through the passageway 39 along the same wall portion 27, cross over at the passageway 37 and be delivered through the passageway 43 on the opposite side.

If, now, an obstruction such as plug 49 be placed in the passageway 43 to block the same, the fluid will then be discharged through the passageway 43*a*. If the obstruction 49 be removed from the passageway 43 the flow will then be resumed through that passageway, thus exhibiting memory, and will no longer flow through the passageway 43*a*. The distance separating the passageway 37 from the chamber 26 is such that there is insufficient feed back to cause the jet to switch from one wall portion 27 to the other.

It is thus made possible, in a single structure, to obtain, as desired, either smooth throttling action, or on-off action with memory.

The structure herein described lends itself for demonstration of fluid switching and jet direction control using pure fluid interaction principles.

The removability of the rear divider 40 permits of demonstrating the control of the direction of the jet beyond the passageway 37 proportional to the opening of the inlets 29. With the divider 40 removed, all the fluid will issue as a single jet whose direction is determined by the proportion of the fluid supplied by the passageways 39 and 39*a*.

In one embodiment of the invention it may be used for control purposes with throttling, or with on-off control with memory, as desired.

In another embodiment of the invention, the same can be provided in kit form with the base 10 and plate 14 preformed and as separate pieces, and with the central divider 32 and the rear divider 40 as separate pieces for assembly in different configurations to observe the results.

This application is a continuation in part of my prior application filed July 2, 1962, Serial No. 206,627, now abandoned.

I claim:

1. Fluid flow control apparatus comprising a device having a fluid interaction chamber therein with a throat portion at one end thereof, said chamber having opposite side walls extending continuously in advancing directions with diverging and then converging portions to provide crossing fluid paths at said throat portion, said device having portions providing beyond said throat portion extensions of said paths, a nozzle communicating with said chamber between said walls at the other end thereof, a supply of fluid connected to said nozzle for the delivery of a fluid jet from said nozzle into said chamber, and control ports communicating with said chamber at each of said walls and contiguous to said nozzle for determining the positioning of the jet from said nozzle, the fluid flow through said throat portion being derived solely from said nozzle and said control ports.

2. Fluid flow control apparatus as defined in claim 1 in which the portions providing extensions of said paths have a removable central portion to provide a free central space beyond the crossing of said paths.

3. Fluid flow control apparatus as defined in claim 1 in which a flow obstructing member is provided in one of said extensions.

4. Fluid flow control apparatus as defined in claim 1 in which a plurality of superposed plates are provided in at least one of which the fluid interaction chamber is located, one of said plates has a fluid inlet connection communicating with said nozzle, and one of said plates has terminals of said control fluid connections extending thereto for manual control of distribution of flow thereinto.

5. Fluid flow control apparatus as defined in claim 1 in which a discharge flow divider is provided between said diverging walls and in spaced relation thereto defining diverging discharge passageways.

6. Fluid flow control apparatus as defined in claim 1 in which a discharge flow divider is removably inserted between said diverging walls and in spaced relation thereto defining diverging discharge passageways, said flow divider and at least one of said plates having interengaging portions for locating said flow divider.

7. Fluid flow control apparatus comprising a device having a fluid interaction chamber therein with a throat portion at one end thereof, said chamber having a flow divider, the walls of said divider at the discharge end thereof being in meeting relation in said chamber, said chamber having opposite side walls extending continuously in advancing directions with diverging and then converging portions in spaced relation to the walls of said divider to provide with said divider crossing fluid passageways at said throat portion, said device having portions providing extensions of said passageways, a nozzle communicating with said chamber between said walls

at the other end thereof, a supply of fluid connected to said nozzle for the delivery of a fluid jet from said nozzle into said chamber, and control ports communicating with said chamber at each of said walls and contiguous to said nozzle for determining the positioning of the jet from said nozzle.

8. Fluid flow control apparatus as defined in claim 7 in which the portions providing extensions of said passageways have a removable central portion to provide a free central space beyond the crossing of said passageways.

9. Fluid flow control apparatus as defined in claim 7 in which a flow obstructing member is provided in one of said extensions.

10. Fluid flow control apparatus as defined in claim 7 in which a discharge flow divider is provided between said diverging walls and in spaced relation thereto defining diverging discharge passageways.

11. Fluid flow control apparatus as defined in claim 7 in which a discharge flow divider is removably inserted between said diverging walls and in spaced relation thereto defining diverging discharge passageways, said flow divider and at least one of said plates having interengaging portions for locating said flow divider.

12. Fluid flow control apparatus as defined in claim 7 in which the extensions of said passageways have outer walls offset outwardly from said throat.

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LAVERNE D. GEIGER, *Primary Examiner.*

Notice of Adverse Decision in Interference

In Interference No. 95,450 involving Patent No. 3,177,888, C. B. Moore, CONTROL APPARATUS, final judgment adverse to the patentee was rendered Nov. 6, 1968, as to claim 1.

[*Official Gazette June 3, 1969.*]

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[*Official Gazette June 3, 1969.*]