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FLUID MEMORY APPARATUS

Filed Nov. 27, 1964

FIG. 1

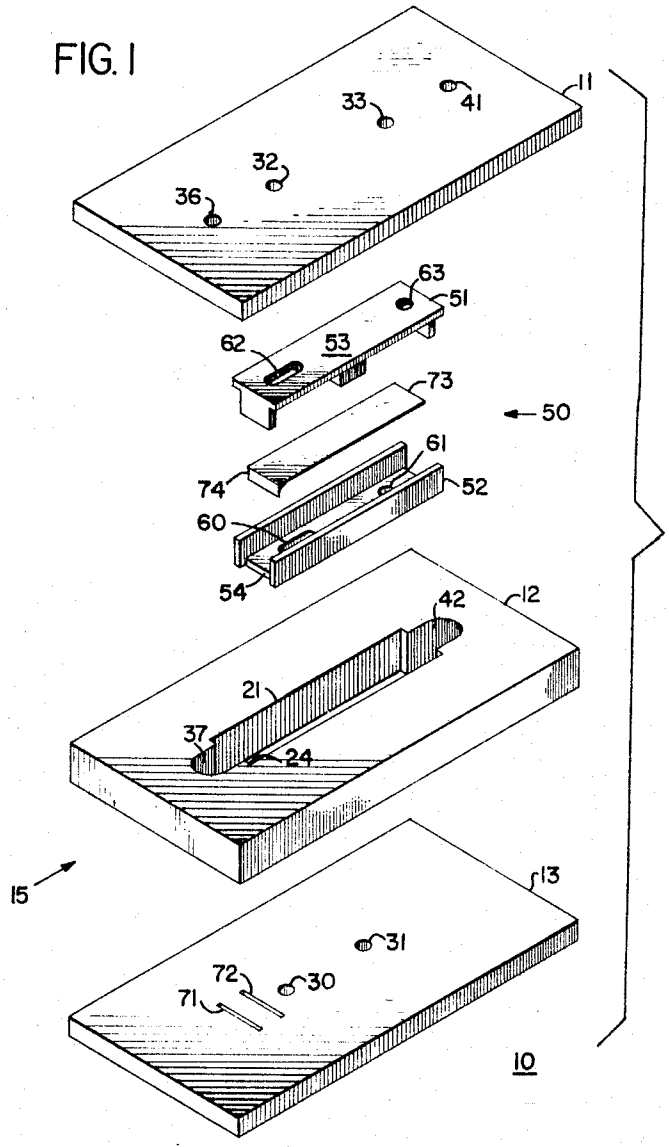
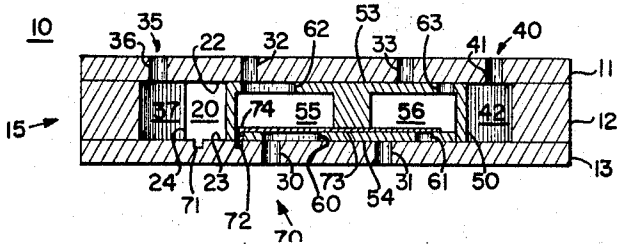


FIG. 2



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FLUID MEMORY APPARATUS

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This invention pertains to fluid devices, and more particularly to fluid binary memory devices.

The recent development of fluid logic components and fluid computer systems has created a demand for permanent binary data storage devices activated by a fluid medium. The applicant has provided a unique fluid memory element having an "enable" input, which makes it especially suited for use with simple accessing circuitry in fluid memory systems. The applicant's fluid memory element also includes "fluid diode" and thereby possesses a "sense" output characteristic which precludes interference with the output of other memory elements connected in parallel. Data stored in the element may be preserved indefinitely without the use of standby power. The construction is such that inexpensive production is obtained with a minimum number of parts of simple shape which are fabricated from moldable and formed materials.

The scope of the invention will become apparent from a study of the accompanying specification and claims in conjunction with the drawing in which:

FIGURE 1 is an exploded view of the applicant's fluid memory device; and

FIGURE 2, the cross sectional view of the assembled fluid memory device.

Referring now to FIGURES 1 and 2, reference manual **10** generally depicts a fluid memory element. A generally rectangular cover plate **11**, a generally rectangular block **12**, and a generally rectangular bottom plate **13** are provided. As illustrated in FIGURE 2, cover plate **11** and bottom plate **13** are attached to block **12** by suitable means (such as screws or adhesives) not shown. Thus assembled, cover plate **11**, block **12**, and bottom plate **13** collectively define a housing which is identified by reference **15**. In the embodiment illustrated, housing **15** has a parallelepiped channel **20** formed therein. The sides of a channel **20** are defined by an opening **21** through block **12**. The top surface **22** of channel **20** is formed by cover plate **11**. The bottom surface **23** of channel **20** is formed by bottom plate **13**. An enable passage **30** is provided within housing **15** and is in communication with channel **20**. Enable passage **30** intersects bottom surface **23** of channel **20**. An interrogate passage **31** is provided within housing **15** in communication with channel **20**. Interrogate passage **31** intersects bottom surface **23** of channel **20**.

A vent passage **32** is provided within housing **15** and is in communication with channel **20**. Vent passage **32** intersects top surface **22** of chamber **20**. A sensing passage **33** is provided within housing **15** and is in communication with channel **20**. Sensing passage **33** intersects top surface **22** of channel **20**.

A "zero" input passage **35** is provided within housing **15** and is in communication with channel **20**. "Zero" input passage **35** comprises a conduit **36** through cover plate **11** and an opening **37** in block **12**. A "one" input passage **40** is provided within housing **15** and is in communication with channel **20**. "One" input passage **40** comprises a conduit **41** in cover plate **11** and an opening **42** in block **12**.

A shuttle means **50** is positioned within channel **20**. In the particular embodiment illustrated in FIGURES 1 and 2, shuttle means **50** takes the shape of a parallelepipedon. Shuttle means **50** comprises an upper portion **51** and a lower portion **52**. Upper portion **51** forms the upper surface **53** and the ends of shuttle means **50**.

Lower portion **52** forms the lower surface **54** and the sides of shuttle means **50**. Upper surface **53** of shuttle means **50** is positioned contiguous to surface **22** of channel **20**. Lower surface **54** of shuttle means **50** is positioned contiguous to bottom surface **23** of channel **20**. Shuttle means **50** is slideable within channel **20** from a "zero" position (illustrated in FIGURE 2) to "one" position. Shuttle means **50** is in the "one" position in channel **20** when it is displaced to the left as viewed in FIGURE 2 so that it is adjacent to surface **24** of channel **20**.

A pair of chambers **55** and **56** are formed within shuttle means **50**. There is no fluid communication between chamber **55** and chamber **56**.

An enable aperture **60** is provided within shuttle means **50** and is in communication with chamber **55**. Enable aperture **60** is located in bottom surface **54** of shuttle means **50**. Enable aperture **60** has a larger area than enable passage **30**. Consequently, enable aperture **60** is in communication with enable passage **30** both when shuttle means **50** is in the "zero" position and when the shuttle means **50** is in the "one" position (see FIGURE 2).

A diode aperture **61** is provided within shuttle means **50** and is in communication with chamber **56**. Diode aperture **61** is located in lower surface **54** of shuttle means **50**. Diode aperture **61** has an area substantially equal to the area of interrogate passage **31**. Consequently diode aperture **61** is in communication with interrogate passage **31** only when shuttle means **50** is in the "one" position (see FIGURE 2).

A vent aperture **62** is provided in shuttle means **50** and is in communication with chamber **55**. Vent aperture **62** is located in upper surface **53** of shuttle means **50**. Vent aperture **62** has an area substantially larger than the area of passage **32**. Consequently, vent aperture **62** is in communication with vent passage **32** both when shuttle means **50** is in the "one" position and when shuttle means **50** is in the "zero" position (see FIGURE 2).

A sensing aperture **63**, is provided within shuttle means **50** and is in communication with chamber **56**. Sensing aperture **63** is located in upper surface **53** of shuttle means **50**. Sensing aperture **63** has an area substantially equal to the area of passage **33**. Consequently, sensing aperture **63** is in communication with sensing passage **33** only when shuttle means **50** is in the "one" position (see FIGURE 2).

Locking means **70** are provided for shuttle means **50**. Locking means **70** includes a first groove **71** and a second groove **72** located in bottom surface **23** of channel **20**. Locking means **70** also includes a resilient member **73** having a right angle cleat **74** on one end thereof. Resilient member **73** is positioned between upper portion **51** and lower portion **52** of shuttle means **50**. In this position, member **74** extends a short distance out of shuttle means **50** through an opening provided therefore. Cleat **74** is positioned within groove **72** in FIGURE 2. Locking means **70** functions to lock shuttle means **50** in either the "zero" position or the "one" position.

In operation, "zero" input passage **35** and "one" input passage **40** are connected to the proper signal source. Enable passage **30** and interrogate passage **31** are connected to a fluid signal source. Sensing passage **33** is connected to a suitable register.

Shuttle means **50** is illustrated in the "zero" position in FIGURE 2. In the "zero" position, a pressure pulse through interrogate passage **31** will be stopped by the bottom surface **54** of shuttle means **50**. Thus, no signal is transmitted to the sensing passage **33**, thereby indicating a "zero" position to the register.

To write "one" into memory element **10** a pressure pulse must first be applied to enable passage **30**. The pulse is communicated through enable aperture **60** to

the resilient member **73** covering aperture **60**. The pressure pulse forces member **73** in an upward direction, as viewed in FIGURE 2, thereby lifting cleat **74** from groove **72** thereby disabling locking means **70** and unlocking shuttle means **50**. Shuttle means **50** is now free to move within channel **20**. A pressure pulse is applied to "one" input passage **40** forcing shuttle means **50** to the left against surface **24**. The pressure pulse applied to "one" input passage **40** may either be coincident with or slightly delayed from the pressure pulse applied to enable passage **30**. At the end of the enable pulse, cleat **74** of member **73** extends downwardly into groove **71** in bottom surface **23** of chamber **20**. Shuttle means **50** is now locked in the "one" position. In the "one" position, enable passage **30** is in communication with enable aperture **60** and vent passage **32** is in communication with vent aperture **62**. In addition, interrogate passage **31** is in communication with diode aperture **61** and sensing passage **33** is in communication with sensing aperture **63**.

To read the information out of memory **10**, a pressure pulse is applied to interrogate passage **31**. The pressure pulse in interrogate passage **31** is conveyed to diode aperture **61** and forces member **73** in an upward direction, as viewed in FIGURE 2, uncovering aperture **61** and allowing the pulse to enter chamber **56**. The pressure pulse from interrogate passage **31** is conveyed from chamber **56** through sensing aperture **63**, through sensing passage **33**, and into the register connected thereto. A pressure pulse appearing in sensing passage **33** indicates a "one" condition.

Memory element **10** must be connected in parallel with other memory elements identical thereto in most applications. All of the elements are capable of reading information into the same register. Thus, provision must be made to prevent the pressure pulse in sensing output passage **33** from being exhausted back through other memory elements connected in parallel. The applicant has solved this problem by covering diode aperture **61** with member **73**. This design functions as a fluid diode permitting fluid flow in only one direction through element **10**. More specifically, member **73** of locking means **70** allows flow into chamber **56** through diode aperture **61** and prevents fluid flow out of chamber **56** through diode aperture **61**.

To write "zero" into memory element **10** a pressure pulse is again applied to the enable passage **30** which forces member **73** upwardly, unlocking shuttle means **50** as previously described. A pressure is then applied to "zero" input passage **35** forcing shuttle means **50** to the right, as viewed in FIGURE 2, to its original position. Shuttle means **50** is illustrated in FIGURE 2 in the zero position. At the end of the pressure pulse in enable passage **30**, cleat **74** moves downwardly into groove **72** locking shuttle means **50** in the "zero" position.

Although the invention has been described and illustrated in detail, it is to be clearly understood that the description is by way of illustration and example only it is not to be taken by way of limitation. The scope of the invention is limited only by the terms of the attendant claims.

I claim:

1. A fluid memory element comprising:

a housing, said housing having a parallelepiped channel therein, said channel having a top surface and a bottom surface;

an enable passage within said housing in communication with said channel, said enable passage intersecting said bottom surface;

an interrogate passage within said housing in communication with said channel, said interrogate passage intersecting said bottom surface;

parallelepiped shuttle means having a first surface and a second surface thereon, said shuttle being positioned within said channel with said first surface contiguous to said top surface and said second surface contiguous to said bottom surface, said shuttle means being slideable from a first position to a second position within said channel;

a first chamber and a second chamber within said shuttle means;

an enable aperture through said second surface of said shuttle in communication with said first chamber, said enable aperture being in communication with said enable passage when said shuttle is in said first position and when said shuttle is in said second position;

a diode aperture through said second surface of said shuttle in communication with said second chamber, said diode aperture being in communication with said interrogate passage only when said shuttle is in said second position;

a diode aperture through said second surface of said shuttle in communication with said second chamber, said diode aperture being in communication with said interrogate passage only when said shuttle is in said second position;

locking means, said locking means including a first groove and a second groove within said bottom surface of said channel, said locking means including a member normally extending out of said shuttle, said member coacting with said first groove so as to lock said shuttle in said first position, said member coacting with said second groove so as to lock said shuttle in said second position, said locking means being disabled in response to fluid flow through said enable passage and said enable aperture, said locking means allowing fluid flow into said second chamber through said diode aperture and preventing fluid flow out of said second chamber through said diode aperture;

a vent aperture through said first surface of said shuttle in communication with said first chamber, said vent aperture being in communication with said vent passage when said shuttle is in said first position and when said shuttle is in said second position;

a sensing passage within said housing intersecting said top surface, said sensing passage being in communication with said channel;

a sensing aperture through said first surface of said shuttle in communication with said second chamber, said sensing aperture being in communication with said sensing passage only when said shuttle is in said second position;

a first input passage within said housing in communication with said channel, the unlocked shuttle being placed in said first position in response to fluid flow through said first input passage;

a second input passage within said housing in communication with said channel, the unlocked shuttle being placed in said second position in response to fluid flow through said second input passage.

2. A fluid memory element comprising:

a housing, said housing having a channel therein;

an enable passage within said housing in communication with said channel;

an interrogate passage within said housing in communication with said channel;

shuttle means, said shuttle being positioned within said channel, said shuttle means being slidable from a first position to a second position within said channel;

a first and second chamber within said shuttle means;

an enable aperture through said shuttle means in communication with said first chamber, said enable aperture being in communication with said enable passage when said shuttle means is in said first position and when said shuttle means is in said second position;

a diode aperture through said shuttle means in communication with said second chamber, said diode aperture being in communication with said interrogate passage only when said shuttle means is in said second position;

locking means, said locking means including a member normally extending out of said shuttle means, said member coacting with said housing so as to lock said shuttle in said first position and coacting with said housing so as to lock said shuttle in said second position, said locking means being disabled in response to fluid flow through said enable passage and said enable aperture, said locking means allowing fluid flow into said second chamber through said diode aperture;

a vent passage within said housing in communication with said channel;

a vent aperture through said shuttle means in communication with said first chamber, said vent aperture being in communication with said vent passage when said shuttle means is in said first position and when said shuttle means is in said second position;

a sensing aperture through said shuttle means in communication with said second chamber, said sensing aperture being in communication with said sensing passage only when said shuttle means is in said second position;

a first input passage within said housing in communication with said channel, the unlocked shuttle being placed in said first position in response to fluid flow through said first input passage; and

a second input passage within said housing in communication with said channel, the unlocked shuttle being placed in said second position in response to fluid flow through second input passage.

3. A fluid memory element comprising;

means forming a channel;

an enable passage in communication with said channel;

an interrogate passage in communication with said channel;

shuttle means, said shuttle means being positioned with said channel, said shuttle means being slidable from a first position to a second position within said channel, a first and a second chamber within said shuttle means;

an enable aperture through said shuttle means in communication with said first chamber, said enable aperture being in communication with said enable passage when said shuttle means is in said first position and when said shuttle means is in said second position;

a diode aperture through said shuttle means in communication with said second chamber, said diode aperture being in communication with said interrogate passage only when said shuttle means is in said second position;

locking means, said locking means being effective to lock said shuttle means in said first position and to lock said shuttle means in said second position, said locking means being disabled in response to fluid flow through said enable passage and said enable aperture, said locking means allowing fluid flow into said second chamber through said diode aperture and preventing fluid flow out of said second chamber through said diode aperture;

a vent aperture through said shuttle means in communication with said first chamber, said vent aperture being in communication with said vent passage when said shuttle means is in said first position and when said shuttle means is in said second position;

a sensing passage in communication with said channel;

a sensing aperture through said shuttle means in communication with said second chamber, said sensing aperture being in communication with said sensing passage only when said shuttle means is in said second position;

a first input passage in communication with said channel; and

a second input passage in communication with said channel.

4. A fluid memory element comprising:

means forming a channel;

an enable passage in communication with said channel;

interrogate passage in communication with said channel;

a vent passage in communication with said channel;

a sensing passage in communication with said channel;

shuttle means positioned within said channel, said shuttle means being slidable from a first position to a second position within said channel, said shuttle means being effective in said first position and in said second position to provide communication between said enable means passage and said vent passage, said shuttle means being effective in said first position to prevent communication between said interrogate passage and said sensing passage, said shuttle means being effective in said second position to provide communication between said interrogate passage and said sensing passage;

locking means, said locking means effective to lock said shuttle means in said first position and to lock said shuttle means in said second position, said locking means being disabled in response to fluid flow through said enable passage, said locking means allowing fluid flow from said interrogate passage through said sensing passage and preventing fluid flow from said sensing passage through said interrogate passage;

a first input passage in communication with said channel, the unlocked shuttle being placed in said first position in response to fluid flow through said first input passage; and

a second input passage in communication with said channel, the unlocked shuttle being placed in said second position in response to fluid flow through said second input passage.

5. A fluid memory element comprising;

means forming a channel;

an enable passage in communication with said channel;

interrogate passage in communication with said channel;

a sensing passage in communication with said channel;

shuttle means positioned within said channel,

said shuttle means being slidable from a first position to a second position within said channel, said shuttle means being effective in said first position to prevent communication between said interrogate passage and said sensing passage, said shuttle means being effective in said second position to provide communication between said interrogate passage and said sensing passage;

locking means, said locking means being effective to lock said shuttle means in said first position and to lock said shuttle means in said second position, said locking means being disabled in response to fluid flow through said enable passage, said locking means allowing fluid flow from said interrogate passage through said sensing passage and preventing fluid flow from said sensing passage through said interrogate passage;

a first input passage in communication with said channel, the unlocked shuttle being placed in said first position in response to fluid flow through said first input passage; and

a second input passage in communication with said channel, the unlocked shuttle being placed in said second position in response to fluid flow through said second input passage.

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