BI-DIRECTIONAL FLUIDIC ELEMENTS AND CIRCUITS

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Filed: Jan. 26, 1970

U.S. Cl.................................................. 137/1, 137/8.5
Int. Cl.................................................. E03b 1/00, F17d 1/00, F15c 1/14
Field of Search......................................... 137/81.5, 1

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ABSTRACT

A bi-directional fluidic element includes an input-output passage which conducts incoming signals into interacting relationship with a fluid stream to deflect the latter in one sense towards an output passage. Outgoing signals deflect the fluid stream in an opposite sense to cause fluid to flow through the input-output passage in a direction opposite that of incoming signals.

12 Claims, 6 Drawing Figures
3,675,669

BI-DIRECTIONAL FLUIDIC ELEMENTS AND CIRCUITS

BACKGROUND OF THE INVENTION

The present invention relates to fluidic systems, and more particularly to apparatus and methods employing fluidic techniques for propagating fluid signals bi-directionally over a single transmission path.

In many fluid-operated systems cost and space limitations make it desirable to utilize a single signal transmission path to conduct various signals between remote sub-systems. Where signal flow is uni-directional, that is all signals flow from one sub-system to the other, well-known multiplexing techniques can be employed to assure that two or more signals are not transmitted simultaneously. However, where bi-directional fluid signal transmission is required, multiplexing techniques by themselves are not sufficient. For example, consider a fluid-operated system of the type wherein each of two remote sub-systems includes a generating circuit which provides signals to be processed by a utilization circuit at the other sub-system. The primary drawback to using a single fluid signal transmission path to propagate signals bi-directionally between the sub-systems is the lack of proper isolation between the generating circuit and the utilization circuit at each sub-system location. More particularly, it is necessary at each sub-system to prevent the received signal from affecting the signal generating circuit, and to prevent the generated signal from affecting the signal utilization circuit. In electronics this isolation is readily achieved by utilizing diodes to block undesired signal flow. However, fluidic diodes developed heretofore have proven incapable of providing the isolation required for most system applications. Consequently, fluid-operated systems must employ a different approach to achieving the circuit isolation required for bi-directional signal propagation in a single flow path.

It is therefore an object of the present invention to provide a workable method for propagating fluid signals bi-directionally in a single flow path.

It is another object of the present invention to provide a fluidic element capable of receiving fluid signals at and transmitting fluid signals from a single fluid passage.

It is another object of the present invention to provide a method and apparatus for transmitting fluid signals bi-directionally through a single signal transmission path.

It is still another object of the present invention to provide a fluidic amplifier capable of amplifying fluid signals transmitted along a single signal transmission path in either of two directions.

Another type of fluid-operated system in which bi-directional fluid flow through a single transmission path is often advantageous is the fluid logic system. For example, in electrical systems there are relays which carry current through their coils in either direction and thereby permit their relay arms to provide a closure in either of two logic function paths. Since the contacts of the relay can carry current in either direction, a single relay arm can conduct current in one direction when forming part of one logic function path and in the other direction when forming part of the second logic function path. There is no prior art fluidic analog of this electrical relay. Such an analog, as provided herein, would permit a considerable saving in the number of logic elements required to perform certain logic functions.

It is therefore another object of the present invention to provide a bi-directional fluidic gate capable of selectively passing fluid signals in either of two directions in accordance with existing logic conditions.

Another object of the present invention is to provide a bi-directional fluidic gate capable of selectively passing signals in either of two directions along a single fluid transmission path.

It is yet another object of the present invention to provide a method of selectively permitting and inhibiting passage of fluid signals in either of two directions along a single fluid transmission path.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention a modified analog fluidic amplifier configuration is employed for both receiving and transmitting fluid signals over a single bi-directional transmission line. The amplifier is of the active type wherein a power stream of fluid is selectively deflected relative to one or more receiver passages as a function of one or more input signals. One of the receiver passages is configured to conduct portions of the power stream into the transmission path when the power stream is deflected toward that receiver by a locally generated signal. The same receiver passage is also configured to receive signals from the transmission path and direct these signals into deflecting relationship with the power stream, whereby the power stream is deflected toward a second receiver passage as a function of the signal received from the transmission path. A signal utilization circuit receives signals from the second receiver passage. By using this element to receive and transmit signals over a single bidirectional path, one avoids all interaction between the local signal generating circuit and the local signal utilization circuit at any sub-system location.

The amplifier interaction region is configured to permit an incoming signal from the signal transmission path to be vented after deflecting the power stream, as required. Depending upon the amplifier configuration, the amplification of signals in either direction can be made linear functions of the input signal. The interaction region may also be configured to provide boundary layer effects in cases where digital signal transmission is desired.

More than one receiver passage may be configured to receive and transmit signals in which case the element can be configured symmetrically to serve as a repeater amplifier. Such an amplifier would be located in a bi-directional transmission line to amplify signals propagated in either direction. The single repeater amplifier would thus compensate for transmission line losses.

In another aspect of the present invention a bi-directional AND gate is provided wherein three signal paths terminate at an interaction region and are arranged such that the presence of any single signal produces no output signal and the presence of any two simultaneous input signals produces an output signal in a predetermined one of the signal paths. In one embodiment the three signal paths are spaced mutually by 120° and a signal provided by any one when none of the others are present is directed to a respective one of three 120° spaced vent passages. A signal received by one of the signal paths can then selectively be transmitted to second of the signal paths when a signal is present at the third signal path. Likewise, signals may be transmitted from the second signal path to the first signal path if a signal is present at the third signal path.

The bi-directional amplifier and the bi-directional AND gate may be employed together or separately in fluidic systems to provide a bi-directional flow capability in a single transmission path. In addition, these elements may be employed in logic systems to achieve bi-directional flow in a manner which substantially minimizes the number of logic elements required to perform a given logic function.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of specific embodiments thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a diagrammatic representation of a circuit employing a pair of bi-directional signal converter elements of the present invention;

FIG. 2 is a diagrammatic representation of a modified version of the converter element employed in the circuit of FIG. 1;
FIG. 3 is a diagrammatic representation of still another modified version of the converter element employed in the circuit of FIG. 1.

FIG. 4 is a diagrammatic representation of a bi-directional AND gate provided in accordance with one aspect of the present invention.

FIG. 5 is a diagrammatic representation of still another embodiment of a bi-directional signal converter of the present invention.

FIG. 6 is a plan view of a typical fluidic circuit employing the bi-directional elements illustrated in FIGS. 1 and 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1 of the accompanying drawings, there is illustrated a circuit employing two substantially identical fluidic elements 10 and 10' configured in accordance with the principles of the present invention. Formation of the various nozzles, passages, and regions which comprise elements 10 and 10' is accomplished in accordance with principles well-known in the fluidics art and set forth, by way of example, in U.S. Pat. No. 3,425,430.

Element 10 includes an interaction region 11 into which fluid flows in the form of a power stream issues via a power nozzle 13, to permit fluid flow. Interaction region 11 is laterally extended to form a left vented recess 15. The right side of interaction region 11 is terminated by a sidewall 17 which is sufficiently remote from the power stream issued by a power nozzle 13 to prevent boundary layer attachment of the stream to the sidewall. Left and right control nozzles 19 and 21 respectively, are arranged to respond to application of pressurized fluid thereto, to issue respective control streams into the upstream end of interaction region 11 on opposite sides of the power stream issued by power nozzle 13. The control streams are preferably perpendicular to the power stream and interact therewith to provide power stream deflection to a degree dependent upon the relative strengths of the control streams.

A central output passage 23 opens into the downstream end of interaction region 11 on an axis coaxial with the longitudinal axis of power nozzle 13. The width of central output passage 23 is such that the power stream, when un-deflected, is received substantially in its entirety by the central output passage. A left output passage 25, separated from central output passage 23 by flow divider 27, communicates with the left side of the downstream end of interaction region 11 to receive power stream fluid when the power stream is deflected to the left. The width of passage 25 is chosen in accordance with the type of amplification desired; more specifically, if pressure, flow, or power amplification is required, appropriate output passage widths may be selected in accordance with the principles described in the aforementioned U.S. Pat. No. 3,425,430.

A right outlet passage 29 is separated from central output passage 23 by a flow divider 31 and is defined between flow divider 31 and the extension of interaction region sidewall 17. Right outlet passage 29 is significantly wider than outlet passage 25. More particular, outlet passage 29 is contoured to permit fluid flow therethrough in both directions with minimal pressure loss.

Fluidic element 10' is substantially identical to fluidic element 10 with the exception that each is a mirror image of the other. Consequently, the left side of element 10' corresponds to the right side of element 10 and vice versa. The various nozzles, passages, and other portions of element 10' are designated by the same reference numerals which designate corresponding parts of element 10 with the exception that the numerals designating components of element 10' are all primed.

Bi-directional outlet passages 29 and 29' are interconnected via a single fluid flow passage 33 which is likewise configured to permit flow in both directions with minimal pressure loss. In the usual case elements 10 and 10' are located remote from one another. At the location of element 10 there is a signal generator circuit 35, which provides a signal to be transmitted to the location of element 10' for use by a utilization circuit 37'. Likewise, a signal generator circuit 35' at the location of element 10' provides a signal which is utilized by the utilization circuit 37 at the location of element 10. The signals provided by circuit 35 and 35' are applied to control nozzles 19 and 19' respectively. Utilization circuits 37 and 37' are connected to receive signals from outlet passages 25 and 25' respectively. The signal generator circuits 35 and 35' and the utilization circuits 37 and 37' may comprise conventional fluidic elements such as fluidic amplifiers of both the analog and digital types, fluidic switching elements, etc.

A bias signal may be applied to each of control nozzles 21 and 21' to position the power streams of elements 10 and 10', respectively, as desired in the absence of an input signal applied to either element.

In operation, assume that in the absence of signal applied to either of elements 10 and 10', their respective power streams are directed toward central outlet passages 23 and 23'. Assume further that the central outlet passages of both elements are vented to ambient pressure. If a signal is provided by signal generator 35, a corresponding signal is provided in outlet passage 29 by the deflected power stream of element 10. This latter signal is transmitted along transmission path 33 and is received by passage 29' of element 10'. The received signal travels through passage 29' into interaction region 11' where it deflects the power stream of element 10' toward outlet passage 25'. The degree to which the power stream of element 10' is thus deflected depends upon the amplitude of the signal received by passage 25'. Correspondingly, the signal in outlet passage 25', which is a function of deflection to the right of the power stream in element 10', is a corresponding function of the amplitude of the signal received by passage 29'. The signal in passage 25' is then applied to utilization circuit 37' and is processed accordingly. Analogous operation ensures when a signal is provided by a signal generator circuit 35' for use by utilization circuit 37. It is important to note that signals may be transmitted via path 33 in only one direction at a time; however, well-known fluidic switching techniques may be employed to assure that only one signal generator circuit is active at any one time.

An incoming signal received by either of passages 29 and 29' acts to deflect the power stream of the receiving element 10 and 10' sufficiently to permit the incoming signal to be dissipated into the vented central outlet passage 23 and 23'. There is thus no excessive pressure build up in the interaction regions 11 and 11' in response to an incoming signal. Moreover, elements 10 and 10' act as relatively high impedance signal receivers due to the fact that, until the power stream is deflected by the signals received on passages 29 and 29', the power stream closes central channel 23 and 23' to incoming signal flow. In addition, elements 10 and 10', because of the configuration of passages of 29 and 29', act as relatively low impedance signal sources when a signal from generator circuit 35 and 35' is to be amplified and transmitted to a remote station. The end of passage 29 which communicates with interaction region 11 is not to be sufficiently wide to prevent undue pressure loss in signals being transmitted in either direction through passage 29. Of course, the same situation is true for passage 29'.

Various techniques well-known in the fluidics art may be employed to tailor the gain characteristics of amplifiers 10 and 10' as desired. For example, the positive feedback approach described in U.S. Pat. No. 3,468,323 may be employed to linearize the gain characteristics of elements 10 and 10'. In addition, a further vent passage may communicate with interaction regions 11 and 11' through sidewall 17 and 17' if desired.

It will be appreciated that central outlet passages 23 and 23' need not be vented but rather may be utilized to provide output signals from their respective elements. Such signals vary inversely with any input signal applied to the elements.
Referring now to FIG. 2 of the accompanying drawings there is illustrated another fluidic element 10' which is a modified version of elements 10 and 10' of FIG. 1. More particularly, element 10' is constructed substantially similarly to element 10 and has like components designated with similar but double primed reference numerals. The difference between elements 10 and 10' resides in the fact that the sidewalls of interaction region 11 are contoured to permit a relatively small degree of boundary layer attachment thereto. Thus, sidewalk 17' has a section at the upstream end of interaction region 11' which curves sufficiently close to power nozzle 13 to permit the power stream, when deflected toward the left, to have such deflection enhanced by a boundary layer attraction to wall 17'. Likewise, on the right side of the upstream end of interaction region 11', a wall section 18 is provided to aid in deflection of the power stream toward the right once the power stream deflection in that direction has been initiated. Importantly, when a deflection signal is removed from element 10', the boundary layer attachments created by walls 17' and 18 are insufficient to retain the power stream, which consequently returns to its quiescent position directed toward center of some fluid flow to FIG. 10. Element 10' is highly suitable for digital signal transmission since the small amount of positive feedback effect by sidewalks 17' and 18 restore the leading and trailing edges of pulse signals significantly.

Referring now to FIG. 3 of the accompanying drawings there is illustrated a fluidic element 40 which is another modified version of elements 10 and 10' of FIG. 1. Element 40 includes an interaction region 41 which receives a power stream of fluid from power nozzle 43. Left and right control nozzles 45 and 47 respectively provide control streams which interact with and deflect the power stream in interaction region 41. The sidewalks of interaction region 41 are sufficiently removed from power nozzle 43 and its longitudinal axis to prevent boundary layer attachment of the power stream to the sidewalks. A left vent passage 49 and right vent passage 51 communicate between respective left and right sidewalks of interaction region 41 and the ambient pressure environment.

A central outlet passage 53 is in alignment with power nozzle 43 and receives substantially all of the power stream fluid issued by power nozzle 43 when the power stream is undeflected. Passage 53 may be vented or not as desired. Left and right outlet passages 57 and 59 respectively are separated by respective flow dividers from central outlet passage 53. Passages 57 and 59 are conventional in nature and are configured to conduct fluid flow in only one direction, namely away from interaction region 41 when the power stream is directed to an appropriate one of the output passages. A further fluid divider separates left outlet passage 56 from left input-output passage 61. Likewise, a right input-output passage 63 is separated by a flow divider from right outlet passage 59. Passages 61 and 63 are similar in configuration to passage 59 in FIG. 1 and are arranged to conduct fluid flow in each of two directions.

In operation, the power stream in element 40 can be deflected to the right upon reception of a signal at either left control nozzle 45 or left input-output passage 61. Then deflected to the right by such signals, the power stream provides some fluid flow in the right outlet passages. A fluid nozzle 47 or right input-output passage 63 produces a deflection of the power stream to the left so that a portion of the power stream flows into both left outlet passage 57 and left input-output passage 61. It may be seen that if control array 40 is inserted in a transmission line with passages 61 and 63 connected to respective sections of the transmission line, a signal traversing the transmission line in either direction is amplified by element 40. Likewise, element 40 can have a signal applied to either of its control nozzles and thereby introduce an amplified version of that signal in either direction along the transmission line. The symmetry of element 40 permits this bi-directional amplification mode of operation.

The element of FIG. 3, in addition to providing repeater type action whereby it amplifies signals transmitted in either direction along the transmission path to which it is connected, also provides independent output signals via output passages 73, 75, and 77. More particularly, output passages may be employed to monitor signals being transmitted along the transmission line. In addition, element 40 may be operated as a conventional pure fluid amplifier of the analog type if input-output passages 61 and 63 are vented and only output passages 57, 59, and 73 are employed to receive the power stream as a function of the power nozzles 45 and 47. Likewise, output passages 57 and 59 can be deleted in their entirety if desired.

Referring now to FIG. 4 of the accompanying drawings there is illustrated bi-directional AND-gate 70 constructed in accordance with the principles of the present invention. In its preferred form, AND-gate 70 comprises three signal passages 71, 73, and 75, each capable of conducting fluid flow in either of two directions, and each having one end terminating at an interaction region 77. The ends of passages 71, 73, and 75 which communicate with interaction region 77 are mutually spaced by 120°. Three vented passages 79, 81 and 83 also communicate with interaction region 77 in a 120° spaced relationship. Vent passage 79 is aligned across interaction region 77 with signal passage 71 so that flow from the latter, when undeflected, is vented via passage 79. In substantially the same manner, vent passage 81 vents undeflected flow from signal passage 73 and vent passage 83. Vents undeflected flow from signal passage 75.

In one possible mode of operation for AND-gate 70 assume that passages 73 and 75 are connected to respective sections 85a and 85b of a fluid signal transmission line which interconnects two fluidic elements or circuits. Assume further that a signal A is selectively applied to signal passage 71; that output flow from signal passage 73 to transmission line section 85a is designated signal B; that input signal provided by transmission line section 85a to signal passage 73 is designated signal C; that signal provided from signal passage 75 to transmission line section 85b is designated as signal D; and that signal provided by transmission line section 85b to transmission line section 85a can be effected only if signal A is present in signal passage 71. Likewise, in order to provide signal B at transmission line section 85c in response to signal E applied at transmission line section 85a, signal B must be present in output passage 71. If signal A is not present, signal E is vented via passage 83. Thus, the absence of signal A effectively blocks passage of signals between transmission line sections 85a and 85b regardless of direction whereas the presence of signal A permits the passage of these signals in either direction. Again it should be pointed out that simultaneous signal passage in both directions is not possible with element 70 or with the elements discussed hereinafter.

It should be further pointed out that AND-gate 70 can serve to amplify signals passing between signal passages 73 and 75 if signal A, applied to signal passage 71 is a power stream and the angular spacing between signal passages 73 and 75 is adjusted to permit amplified power stream deflection by signals C and E. Element 70, thus modified, closely approximates the configuration of element 40 in FIG. 3, opposite the control nozzles and uni-directional output passages. In addition, element 70 can also be employed in a mode where the signal output passage 71 is bi-directional so that any combination of two signal passages receiving an input signal can provide a corresponding output signal at the remaining signal passage. In any event, the angles between signal passages 71, 73, and 75 must be chosen such that the relative moments of two input signals in two of the passages produces a resultant signal in the remaining passage.

Logic systems requiring bi-directional signal transmission capabilities in certain channels are sometimes highly economy.
particularly interlock circuits of some degree of complexity. A bi-directional capability can save as much as 50 percent in the required elements required as compared with the use of prior art uni-directional logic elements.

Referring now to FIG. 5 of the accompanying drawings there is illustrated another bi-directional element 90 which is capable of serving as an amplifier for signals traveling in each of two directions in a transmission line. More particularly, element 90 comprises an interaction chamber 91 which is substantially oval shaped and is arranged to receive a power stream of fluid at its upstream end from a power nozzle 93. The downstream end of chamber 91 opens to a region from which three fluid passages, 95, 97, and 99 extend. Passage 99 is aligned with power nozzle 93 so that the power stream, when undeflected by a signal, does not attach to either sidewall of chamber 91 and consequently flows through central passage 99. Fluid passages 95 and 97 are designed to conduct fluid in either of two directions, and preferably are connected to respective portions of the transmission line to permit bi-directional signal flow therethrough.

As a signal flows in either direction in passages 95 and 97, the power stream is received by central passage 99 and is either vented or otherwise utilized as desired. If a signal is received in passage 95 the power stream is deflected to the right, as viewed in FIG. 1, so that a portion of the power stream fluid is peeled off by cusp 101 which marks the intersection of the right sidewall of chamber 91 and one sidewall of input-output passage 97. The fluid thus peeled off recirculates in a clockwise direction back upstream along the right sidewall of chamber 91 to form a vortical flow pattern in the chamber and acts to deflect the power stream to the left. The power stream when deflected to the left follows the first sidewall of chamber 91 and issues into right input-output passage 97. Thus, the signal received by input-output passage 95 causes the power stream to flow in input-output passage 97 and an amplified version of the received signal is transmitted further along the transmission line. Upon termination of the signal received by passage 95, the venting of chamber 91 via bore 96, returns to its central position in which it is directed to central output passage 99.

In like manner, a signal received by input-output passage 97 deflects the power stream slightly to the left so that a portion of the power stream fluid is peeled off by left cusp 103. The peeled off fluid recirculates in a counter clockwise direction in chamber 91, deflecting the power stream against the right chamber sidewall. The power stream when thus deflected issues into input-output passage 95 to thereby provide an amplified version of the signal received by input-output passage 97.

Element 90 thus provides a simple yet effective repeater action for fluid transmission lines, permitting amplification of fluid signals transmitted in either direction along the transmission line.

Referring now to FIG. 6 of the accompanying drawings there is illustrated in plan view a fluidic circuit employing elements 10 and 10' of FIG. 1 and element 70 of FIG. 4. More particularly, element 70 has signal passage 71 arranged to receive a selectively actuable signal A. Signal passage 73 is connected to input-output passage 29 of fluidic element 113 which is substantially identical to fluidic element 10' of FIG. 1. Signal passage 75 of element 70 is connected to input-output passage 29' of fluidic element 111 which is also substantially identical to element 10' of FIG. 1. Right outlet passage 25' of fluidic element 111 is connected to a control nozzle 115 of a fluidic OR/NOR-gate 117, for example of the type illustrated in FIG. 3 of my U.S. Pat. No. 3,246,661. Right output passage 25 of fluidic element 111 is connected to control port 119 of fluidic OR/NOR-gate 121, for example of the same type as fluidic OR/NOR-gate 117.

To conform with the signal nomenclature employed in describing FIG. 4, consider an input signal C applied to control nozzle 19' of fluidic element 113. The power stream of element 113 is deflected into input-output passage 29 thereof and is received by signal passage 73 of bi-directional AND-gate 70. If signal A is not present at signal passage 71, the amplified version of signal C is vented via vent passage 81 and no signal is transmitted to element 111. If however signal A is present a signal is transmitted via signal passage 75 to input-output passage 29' of element 111. This signal deflects the power stream of element 111 toward right outlet passage 25' which in turn provides a signal to control nozzle 115 of fluidic OR/NOR-gate 117. The latter responds by providing signal D at its OR output passage 118.

A similar procedure ensures if an input signal E is applied to right control nozzle 19' of fluidic element 111. Signal E deflects the power stream of element 111 to input-output passage 29' thereof. This signal is vented by passage 83 in element 70 in the absence of signal A at signal passage 71. If however, signal A is present a signal is provided via signal passage 73 at input-output passage 29' of element 113. This signal deflects the power stream of element 113 into right outlet passage 25' thereof and in turn to control nozzle 119 of OR/NOR-gate 121. This results in provision of output signal B at the OR output passage 122 of gate 121.

FIG. 6 thus illustrates a logic circuit in which binary signals can be transmitted in either direction through elements 111, 70, and 113. If analog rather than digital signals are employed, fluidic OR/NOR-gates 117 and 121 may be replaced by conventional analog fluidic amplifiers, and analog amplification provided by elements 111 and 113 may be preserved. Likewise, as described above in relation to FIG. 4, by appropriately configuring element 70, the latter may also be used to effect amplification.

While I have described and illustrated specific embodiments of my invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

I claim:
1. In combination:
   a single transmission path, having first and second ends, for propagating fluid signals applied thereto in each of two directions;
   generator means for applying a fluid signal to said first end of said transmission path for propagation to said second end; and
   a fluidic element disposed at said second end comprising:
   an interaction region; means for issuing a power stream of fluid into said interaction region; an input-output passage arranged to conduct fluid in each of two directions and having one end connected to said second end of said transmission path to permit fluid flow between said input-output passage and said transmission path, said input-output passage having another end disposed to receive power stream fluid from said interaction region when said power stream is deflected in a first sense and to issue fluid received from said generator means into said interaction region to deflect said power stream in a second sense opposite said first sense; input means for deflecting said power stream in said second sense; output means for receiving power stream fluid from said interaction region when said power stream is deflected in said second sense, wherein said generator means comprises a second fluidic element of substantially the same configuration as said first-mentioned fluidic element, the input-output passage of said second fluidic element being connected to said interaction region at said second end of said transmission path.
2. In combination:
   a single transmission path, having first and second ends, for propagating fluid signals applied thereto in each of two directions;
   generator means for applying a fluid signal to said first end of said transmission path for propagation to said second end; and
a fluidic element disposed at said second end comprising an interaction region; means for issuing a power stream of fluid into said interaction region; an input-output passage arranged to conduct fluid in each of two directions and having one end connected to said second end of said transmission path to permit fluid flow between said input-output passage and said transmission path, said input-output passage having another end disposed to receive power stream fluid from said interaction region when said power stream is deflected in a first sense and to issue fluid received from said generator means into said interaction region to deflect said power stream in a second sense opposite said first sense; input means for deflecting said power stream in said one sense; and output means for receiving power stream fluid from said interaction region when said power stream is deflected in said second sense; wherein said generator means includes means for receiving and utilizing fluid signals transmitted from said second end to said first end of said transmission path; said combination further comprising bi-directional fluidic gating means interposed in said transmission path for selectively inhibiting propagation of fluid signals along said transmission path in each of said two directions.

3. The combination according to claim 2 wherein said bi-directional fluidic gating means comprises:

a further interaction region;
a first fluid signal passage for conducting fluid signals propagated in one of said two directions along said transmission path into said further interaction region;
a second fluid signal passage into said further interaction region propagated by the other of said two directions along said transmission path into said further interaction region; and
control means for selectively directing fluid signals conducted into said further interaction region by said first fluid signal passage into said second fluid signal passage and for selectively directing fluid conducted into said further interaction region by said second fluid signal passage into said first fluid signal passage.

4. The combination according to claim 3 wherein said control means includes a third fluid signal passage for issuing pressurized fluid applied thereto into said further interaction region at an angle such that said pressurized fluid deflects fluid received from said first fluid signal passage into said second fluid signal passage and deflects fluid received from said second fluid signal passage into said first fluid signal passage.

5. The combination according to claim 4 wherein said first, second and third fluid signal passages are arranged to issue fluid streams into said further interaction region at angles of 120° with respect to one another, said fluidic gating means including means for venting from said further interaction region all fluid which is conducted to but not deflected in said further interaction region.

6. In combination:
a single transmission path, having first and second ends, for propagating fluid signals applied thereto in each of two directions;
generator means for applying a fluid signal to said first end of said transmission path for propagation to said second end; and

a fluidic element disposed at said second end comprising an interaction region; means for issuing a power stream of fluid into said interaction region; an input-output passage arranged to conduct fluid in each of two directions and having one end connected to said second end of said transmission path to permit fluid flow between said input-output passage and said transmission path, said input-output passage having another end disposed to receive power stream fluid from said interaction region when said power stream is deflected in a first sense and to issue fluid received from said generator means into said interaction region to deflect said power stream in a second sense opposite said first sense; input means for deflecting said power stream in said one sense; and output means for receiving power stream fluid from said interaction region when said power stream is deflected in said second sense; wherein said interaction region has two sidewalls which are configured to cause boundary layer effects between said power stream and said sidewalls, said boundary layer effects being sufficient to aid in said applied force in deflecting said power stream toward each sidewall but insufficient to maintain said power stream attached to said sidewalls in the absence of said applied force.

7. The method of transmitting fluid signals between first and second spaced locations wherein first and second fluidic amplifiers are located at said first and second locations, respectively, said amplifiers being of the type wherein a power stream of fluid is issued into an interaction region where it is selectively deflected relative to first and second outlet passages, said method comprising the steps of:

transmitting power stream fluid of said first amplifier when received by said first outlet passage of an amplifier to the interaction region of said second amplifier via a fluid transmission passage and the first outlet passage of said second amplifier, the fluid thus transmitted being directed to deflectively interact with the power stream of said second amplifier;
transmitting power stream fluid of said second amplifier when received by said first outlet passage of said second amplifier to the interaction region of said first amplifier via said fluid transmission passage and the first outlet passage of said first amplifier, the fluid thus transmitted being directed to deflectively interact with the power stream of said first amplifier;
sensing deflection of the power streams of each of said amplifiers in accordance with the fluid received by the second outlet passages of said amplifiers.

8. The method according to claim 7 further comprising the step of selectively gating fluid flowing in said fluid transmission passage to at will inhibit fluid transmission between said first and second amplifiers.

9. The method of transmitting fluid signals between first and second spaced locations wherein first and second fluidic elements are located at said first and second locations, respectively, said fluidic elements being of the type wherein a common input-output passage conducts fluid signals in each of two opposite directions, said method comprising the steps of:

transmitting fluid output signals from said first fluidic element, when received by the input-output passage of said first fluidic element, to the input-output passage of said second fluidic element via a common fluid transmission passage;
transmitting fluid output signals from said second fluidic element, when received by the input-output passage of said second fluidic element, to the input-output passage of said first fluidic element via said common fluid transmission passage; and
sensing reception of fluid signals from said common fluid transmission passage at each of said input-output passages.

10. The method according to claim 9 further comprising the step of selectively gating fluid flowing in said fluid transmission passage to at will inhibit fluid signal transmission between said first and second fluid elements.

11. In combination:
first and second fluidic elements each for generating fluid signals to be transmitted and for receiving fluid signals, each of said fluidic elements comprising an input-output passage and means for sensing the direction of fluid flow through said input-output passage; a common fluid transmission passage extending between first and second spaced locations; wherein said first fluidic element is located at said first location with its input-output passage connected to one end of said common fluid transmission passage in order to both receive from and transmit signals to said second location; and
wherein said second fluidic element is located at said second location with its input-output passage connected to the other end of said common fluid transmission
11 passage in order to both receive from and transmit signals to said first location.

12. The combination according to claim 11 further comprising means located in said common fluid transmission passage for selectively inhibiting fluid signal transmission between said first and second spaced locations.

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