ELECTROMECHANICAL FLUIDIC TRANSDUCER

Filed Sept. 17, 1969

Fig. 1

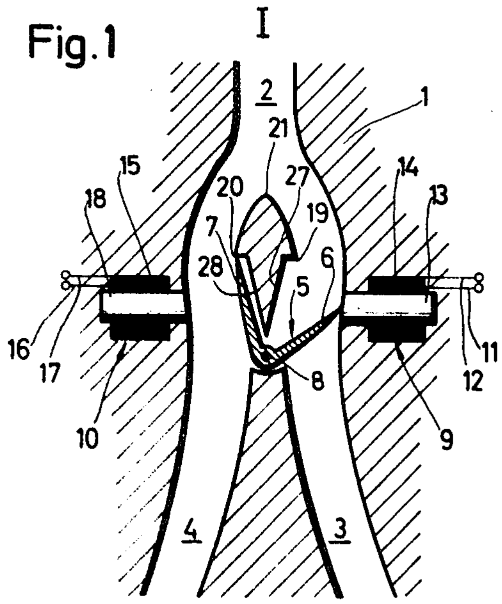


Fig. 2

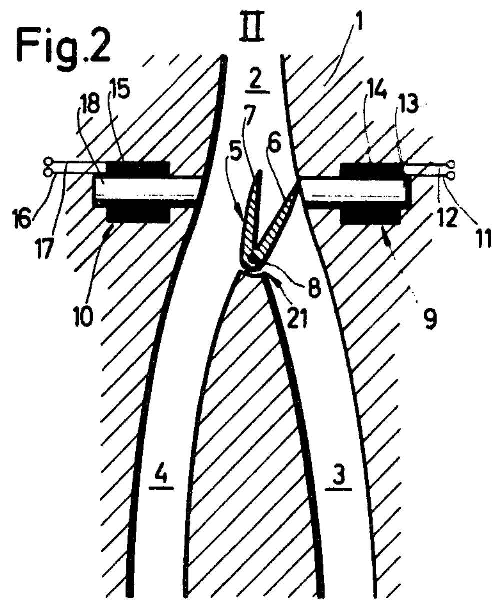


Fig. 3

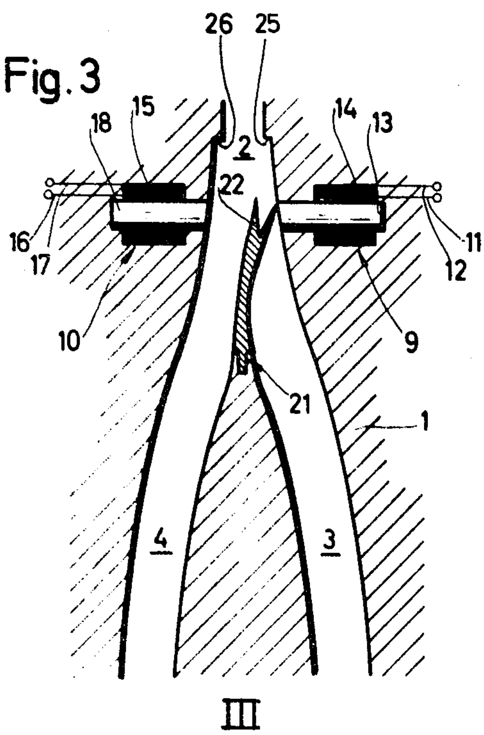
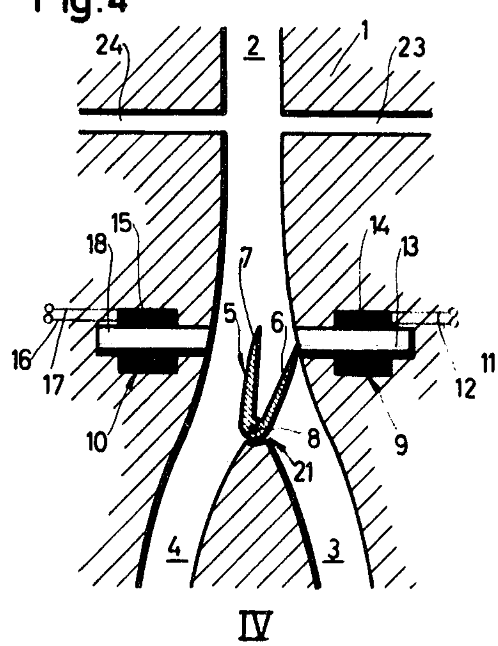


Fig. 4



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ELECTROMECHANICAL FLUIDIC TRANSDUCER

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Filed Sept. 17, 1969, Ser. No. 858,656
Claims priority, application Germany, Sept. 21, 1968, P 17 74 859.3
Int. Cl. F15c 3/08
U.S. Cl. 137—81.5 8 Claims

ABSTRACT OF THE DISCLOSURE

An electromechanical fluidic transducer has a flow feed line communicating with two flow outputs. Two control signal responsive electromagnetic devices are operable to select the flow output, each controlling flow relative to a respective output. A single flow switching element is movable, under the influence of fluid flow, into flow blocking relation in a selected one of the flow outputs, and the switching element is lockable in its blocking position by the associated electromagnetic device. The flow switching element is a forked element, and either may be pivoted at the fork between the two outputs or may be flexible, in the form of a leaf spring. Adjustment canals or ducts communicate with the flow feed or supply line from opposite sides to compensate for asymmetry of the flow control element.

BACKGROUND OF THE PRIOR ART

A known electromechanical fluidic transducer has two control vanes provided in place of the control jets of the conventional jet type fluidic transducers. These control vanes are mounted pivotally or rotatably below the inlet port of the supply jet and, in their rest position, they rest against the walls of the flow chamber. In this arrangement, the fluid or gas flow clings to one wall of the flow chamber, due to the Coanda effect. In order to redirect this flow, the control vane on the flow side can be turned into the flow in a pulse fashion by means of an externally mounted electromagnet.

This known transducer has the drawback that the flow is switched to the other output if the output in use is blocked, or responsive to a temporary backup in the output in use. Due to the mentioned Coanda effect, the flow continues in the new direction even if the previously used output again is free. Furthermore, it is completely uncertain, after an arbitrarily short interruption of the input flow, as to which wall of the flow chamber the flow will cling that is, through which output the flow will proceed.

In another known electromechanical fluidic transducer, a fluid flow of a wall jet element is switched by control currents through laterally arranged control jets. The main flow, after being switched, forces a wedge-shaped obstruction away from that wall along which the flow happens to go. The obstacle or obstruction is provided with electrical contacts and closes a circuit if a respective one of the two side walls of the output opening is touched by the obstruction.

Thereby, fluid signals can be converted into electrical signals with the aid of this transducer, but electrical signals cannot be converted into fluid-mechanical signals. This transducer is not suited for inverse operation, as, for switching in the direction of the flow, by electromagnetic movement of the wedge-shaped obstruction, energies of the order of the dynamic energy of the flowing medium are required. In such inverted operation of this transducer, the control jets furthermore would lose their function.

SUMMARY OF THE INVENTION

This invention relates to electromechanical fluidic transducers and, more particularly, to a novel and improved electromechanical fluidic transducer having a flow feed or supply line and two flow outputs, and in which two electromagnetic devices are operable to select the flow output responsive to electrical signals.

The objective of the invention is to provide an electromechanical fluidic transducer which, in an economical manner, converts weak electrical signals into strong fluid-mechanical signals, and the flow direction of which is changed neither by a brief interruption of the input flow nor by a brief backup in the output then in use, nor by complete blocking of the flow output then in use.

In accordance with the invention, an electromechanical fluidic transducer of the general type mentioned above is provided in which there is associated, with the electromagnetic devices, a signal switching element which, under the influence of the flow, can be moved into one or the other of the flow outputs, and can be locked in this position by the associated electromagnetic device.

In accordance with the preferred form of the invention, the switching element, arranged between the flow outputs of the transducer, is a fork which can rotate about a pivot in such a manner that its blade-shaped ends extend, opposite to the direction of fluid flow, into the two flow outputs. For maximum lateral deflection, one blade-shaped fork end always rests against the outer wall of one flow output, completely closing this flow output, while the other blade-shaped fork end rests against the inner wall of the other flow output. Externally of the flow outputs, and near the free ends of the fork, the electromagnets are arranged and are operable to lock the fork.

The electromagnets operate with holding current, and are so connected that only one electromagnet is energized at any one time. In the operating condition of the transducer, the then energized electromagnet need exert only a weak force to lock the fork end which is adjacent thereto. If the then energized electromagnet is de-energized, by an electric input signal, and the other electromagnet is energized, the fork is rotated to the opposite side and locked in that position by the other electromagnet.

The main energy for switching of the fork is taken from the fluid flow. In addition, the field, just building up, of the magnet then energized acts in an accelerating sense on the fork during rotation of the latter. From this there results the advantage that the rotation of the fork sets in immediately after the switching of the electromagnets, and not only when the field of the electromagnet then energized is fully built up. If both electromagnets are de-energized, the fork oscillates by itself.

In another embodiment of the invention, the fork is pivotally mounted at the vertex of the two flow outputs.

The invention also provides for resiliently mounting, in place of the fork, a leaf spring notched at its free end in the shape of a fork, this leaf spring being positioned at the vertex of the flow outputs. Such a leaf spring can be mounted more simply than a rigid, pivotal fork.

In accordance with a further embodiment of the invention, adjustment canals or ducts are arranged upstream from the free ends of the fork or of the leaf spring, and extend to the flow supply line from two opposite sides. These adjustment canals serve to compensate for asymmetry of the fork or of the leaf spring, or of their mountings. The adjustment canals furthermore make possible to make the switching time to one preferred direction smaller than that to the other direction.

An object of the invention is to provide an improved electromechanical fluidic transducer.

Another object of the invention is to provide such a transducer which, in an economical manner, converts weak electrical signals to strong fluid-mechanical signals.

A further object of the invention is to provide such a transducer in which the flow direction is not changed either by a brief interruption of the input flow, a brief backup in the output then in use, or complete blocking of the flow output then in use.

Another object of the invention is to provide such an electromechanical fluidic transducer in which a single switching element is electromagnetically locked in an adjusted position after having been moved to the adjusted position responsive to fluid flow.

A further object of the invention is to provide such an electromechanical fluidic transducer requiring only a very small energy for electromagnetic locking or holding means.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a sectional view of an electromechanical fluidic transducer, embodying the invention, and having a fork mounted between the flow outputs;

FIG. 2 is a view, similar to FIG. 1, of an electromechanical fluidic transducer having a fork mounted at the vertex of the flow outputs;

FIG. 3 is a sectional view of another embodiment of electromechanical fluidic transducer, in accordance with the invention, and having a leaf spring mounted at the vertex of the flow outputs; and

FIG. 4 illustrates a further embodiment of the invention including adjustment canals in the flow supply line.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, an electromechanical fluidic transducer I includes a non-metallic housing **1** in which are machined or otherwise formed a fluid flow supply line **2** and two symmetrical flow outputs **3** and **4**. Flow outputs **3** and **4** are separated by a part of housing **1** which forms a divider having a point or vertex in the direction toward flow supply line **2**, the vertex being indicated at **21**. Below or downstream of vertex **21**, parts **27** and **28** of the inner walls of the respective flow outputs **3** and **4** are displaced, with respect to each other, so that shoulders **19** and **20**, respectively, are provided.

A switching element, in the form of a symmetrical fork **5** having blade-shaped ends **6** and **7**, is mounted between flow outputs **3** and **4** for pivoting about a pivot **8**. Fork **5** is so balanced that its center of gravity lies at its pivot or fulcrum. The fork may comprise a ferromagnetic metal, or a material containing ferromagnetic metal.

At maximum deflection of fork **5**, for example to the right, blade-shaped fork end **6** closes flow output **3** completely. In this position, the other fork end **7** rests against the inner wall **28** of flow output **4**, below shoulder **20**, so that output **4** is completely open.

In the proximity of the limits of movement of fork ends **6** and **7**, respective electromagnets **9** and **10** are arranged in the outer walls of flow outputs **3** and **4**, and outside of these flow outputs. Electromagnets **9** and **10**, which are shown only schematically in the drawing, each comprises an exciter winding **14** and **15**, respectively, and having respective electrical leads **11, 12** and **16, 17**, and respective electromagnetic cores **13** and **18**. Electromagnets **9** and **10** are so connected that they operate with holding current only, and also so that only one electromagnet **9** or **10** is energized at any one time.

With electromagnets **9** and **10** de-energized, the arrangement operates in the following manner. If a liquid or gas flow is fed through flow supply line **2** and fork **5** is rotated to the right, as in FIG. 1, a part of this flow jams up at the entrance to flow output **3**. The flow then goes through flow output **4**. Vortices form, in this process, at the shoulder **20** under which rests the left blade-shaped fork end **7** at the inner wall **28** of flow output **4**. These vortices pull the fork end **7** into the flow output **4**. As soon as the left fork end **7** is seized by the flow, it is pressed against the outer wall of flow output **4**. At the same time, right fork end **6** is rotated away from the outer wall of flow output **3** and into engagement with the inner wall **27** of this flow output.

In this position of fork **5**, flow jams up in front of flow output **4**. If the output **4** is filled with the flow medium to about the height of vertex **21**, the flow flips over to the flow output **3**. Now vortices are formed in the flow output **3** at the shoulder **19**. These pull the right-hand fork end **6** into the flow output **3**. As soon as this fork end **6** is seized by the flow in output **3**, it is pushed to the outer wall of output **3**. At the same time, the left-hand fork end **7** of fork **5** is rotated away from the outer wall of flow output **4** to the inner wall **28** thereof. Now the flow jams up again in flow output **3** until it again flips over into the output **4**.

In the volume defined by the respective fork ends **6** and **7**, the respective shoulders **19** and **20**, and the respective adjoining parts of the inner walls **27** or **28**, and the surrounding space, rapid pressure equalization is possible, and this prevents damping of oscillation of the fork. For this pressure equalization, there can be used the spaces between fork **5** and the inner walls **27** and **28**, as may be seen from FIG. 1, or special equalization apertures may be provided.

Through the action of electromagnets **9** and **10**, the described arrangement becomes a bistable electromechanical fluidic trandsucer. The electromagnet **9** or **10**, respectively, energized at any one time, has, in the operating condition of the electromechanical fluidic transducer, only to lock the fork end **6** or **7**, respectively, which is adjacent to it, against the outer wall of the respective flow output channel **3** or **4**.

If, for example, the energized electromagnet **9** is de-energized by means of an electric input signal and the other electromagnet **10** is energized, right-hand fork end **6** is no longer locked by electromagnet **9** and fork **5** is rotated to the left up against the outer wall of flow output **4**. In this position, left-hand fork end **7** is locked by the energized electromagnet **10**.

The main energy for pivoting of fork **5** is supplied, as described above, by the flow. Additionally the field, for example of the electromagnet **10**, which is just building up, acts on left-hand fork end **7** in an accelerating manner during pivoting of fork **5**.

A second embodiment of an electromechanical transducer is illustrated in FIG. 2, and is designated with II. It differs from transducer I, of FIG. 1, in that fork **5** is mounted at the vertex **21** of the two flow outputs **3** and **4**. Electromagnets **9** and **10** are arranged, as in FIG. 1, outside the flow passages at the height of the rest positions of fork ends **6** and **7**. Through the arrangement of the fork at vertex **21**, the jammed-up length between fork end **6** or **7**, respectively, and flow feed line **2** is shortened. Thereby, an increase of the frequency of oscillation, and thus of the switching frequency of the transducer, is made possible.

FIG. 3 illustrates an electromechanical fluidic transducer III in which a leaf spring **22**, notched at its upper end to the shape of a fork, is rigidly clamped at vertex **21** of flow outputs **3** and **4** to serve as a switching element. This embodiment of the invention makes possible a simple mounting of the oscillating switching element. The spring force of the leaf spring switching element is, at the same time, utilized for switching of the switching element.

If, as illustrated in FIG. 3, the flowing medium flows through flow output **4**, the Coanda effect occurs below the shoulder **26**, that is, below shoulder **26**, the flow clings to the outer wall of flow output **4**. The flow will stay at this wall if electromagnets **9** and **10** are switched and leaf spring **22** is bent toward the left and specifically until the left-hand fork end **7** rests against the outer wall of flow output **4**. The embodiment of the flow feed line **2** illustrated in FIG. 3 therefore produces an additional protection against leaf spring **22** swinging back due to its own restoring force, and against the influence of the flow, before reaching the maximum lateral deflection. This form of the flow feed line can, of course, also be applied to the embodiments of the invention shown in FIGS. 1 and 2.

The embodiment of the invention shown at IV in FIG. 4 differs from the transducer II, described above, only in that adjustment canals **23** and **24** are arranged upstream of fork **5**, to the right and left, respectively, of flow feed line **2**. These adjustment canals serve to compensate for asymmetries of fork **5** or its mounting. Furthermore, they make possible a decrease in the switching time to one preferred direction as compared to the opposite direction. The adjustment canals **23** and **24**, illustrated in FIG. 4, can, of course, also be used in the other three embodiments of the invention, at the proper location.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. In an electromechanical fluidic transducer having a flow feed line communicating with two flow outputs separated by a divider having a vertex, a single flow switching element oscillatably supported at said vertex and having a free end extending toward said flow feed line, said switching element being movable, under the influence of fluid flow and the difference in the pressures on its opposite lateral surfaces, into flow blocking relation in a selected one of said flow outputs; and at least one control signal responsive electromagnetic device operable to select the flow output to control flow relative to a respective output; said switching element being lockable in its blocking position by an electromagnetic device.

2. In an electromechanical fluidic transducer, as claimed in claim **1**, adjustment canals communicating with opposite sides of said flow feed line and upstream from said switching element.

3. In an electromechanical fluidic transducer having a flow feed line communicating with two flow outputs, two control signal responsive electromagnetic devices operable to select the flow output, and each operable to control flow relative to a respective output; and a single flow switching element movable under the influence of fluid

flow into flow blocking relation in a selected one of said flow outputs; said switching element being lockable in its blocking position by the associated electromagnetic device; a fork constituting said single flow switching element and having blade-shaped ends; said fork being mounted for oscillation about a pivot in a manner such that its blade-shaped ends extend into the two flow outputs against the flow direction.

4. In an electromechanical fluidic transducer, as claimed in claim **3**, said blade-shaped fork ends being so arranged that, at maximum lateral deflection, one blade-shaped fork end always engages an outer wall of a flow output, closing the latter completely, while the other blade-shaped fork end engages the inner wall of the other flow output.

5. In an electromechanical fluidic transducer, as claimed in claim **4**, electromagnets arranged outside the flow outputs in proximity to the flow output wall engaging position of said fork ends, said electromagnets constituting said control signal responsive electromagnetic devices.

6. In an electromechanical fluidic transducer, as claimed in claim **5**, means rotatably mounting said fork substantially at the vertex of the two flow outputs.

7. In an electromechanical fluidic transducer having a flow feed line communicating with two flow outputs, two control signal responsive electromagnetic devices operable to select the flow output, and each operable to control flow relative to a respective output; and a single flow switching element movable under the influence of fluid flow into flow blocking relation in a selected one of said flow outputs; said switching element being lockable in its blocking position by the associated electromagnetic device; a leaf spring mounted substantially at the vertex of said flow outputs and constituting said single flow switching element; the free end of said leaf spring being notched in the shape of a fork.

8. In an electromechanical fluidic transducer, as claimed in claim **7**, said flow feed line being widened, upstream of said switching element, and symmetrically to the flow axis, by lateral displacement of its walls outwardly to form shoulders.

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