United States Patent

[11] **3,566,896**

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[33] **Poland**
[31] **P-119039**

[54] **ELECTROPRESSURE JETSTREAM CONVERSION ELEMENT**
8 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **137/81.5**
[51] **Int. Cl.** **F15c 1/04**
[50] **Field of Search** ..... 137/81.5; - 235/200(WB)

[56] **References Cited**
UNITED STATES PATENTS

3,104,810	9/1963	Lupfer	235/200WB
3,258,685	6/1966	Horton	137/81.5X
3,263,695	8/1966	Scudder et al.	137/81.5
3,273,594	9/1966	Mayer	137/81.5X
3,361,149	1/1968	Meyer	137/81.5
3,380,465	4/1968	Rona	137/81.5
3,428,066	2/1969	Herr	137/81.5
3,452,767	7/1969	Posingies	137/81.5
3,494,369	2/1970	Inoue	137/81.5

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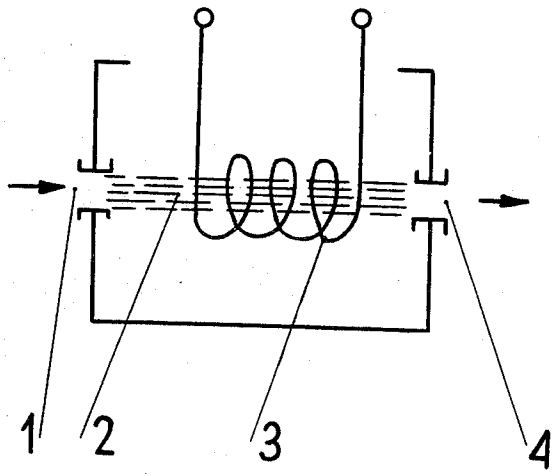
ABSTRACT: An electropressure fluid jetstream conversion element has an electric resistance heater of low thermal inertia in engagement with a jetstream inlet; a variation in an electric current supplied to the resistance heater, such as voltage or frequency, causes a corresponding variation in a sensible property of the jetstream.



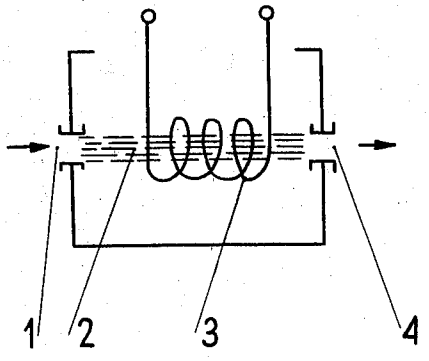


FIG. 1

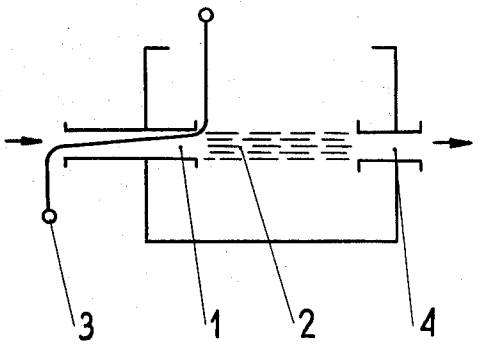


FIG. 2

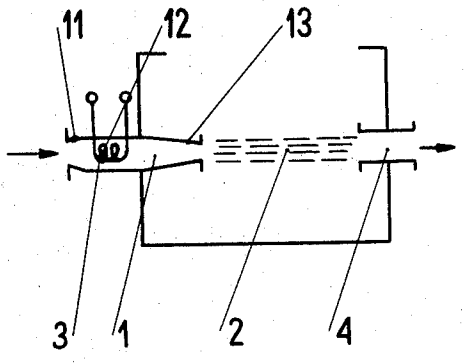


FIG. 3

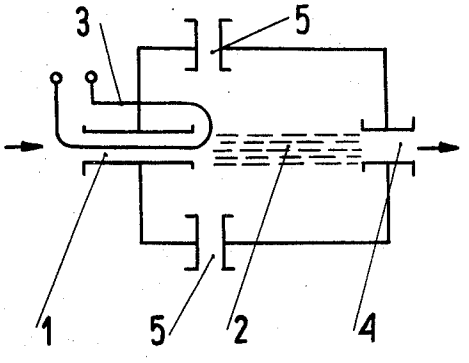


FIG. 4

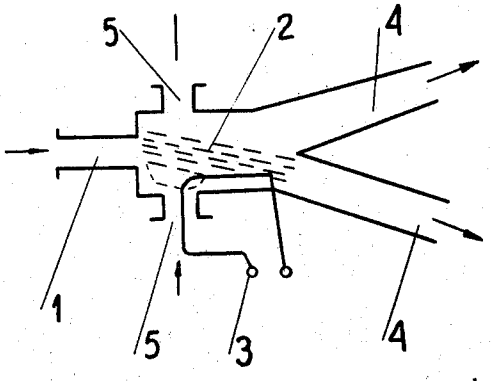


FIG.5

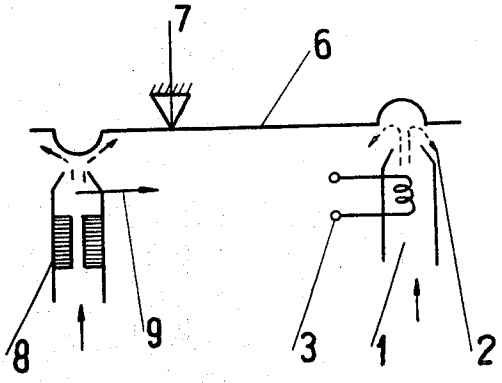


FIG.6

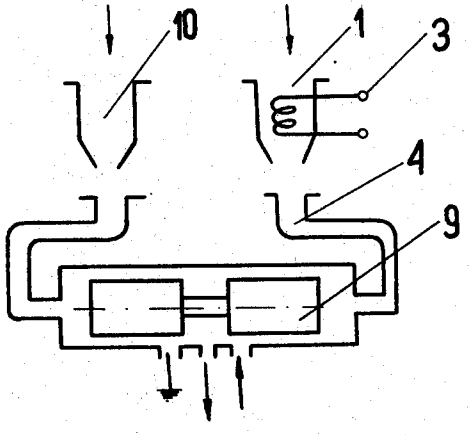


FIG.7

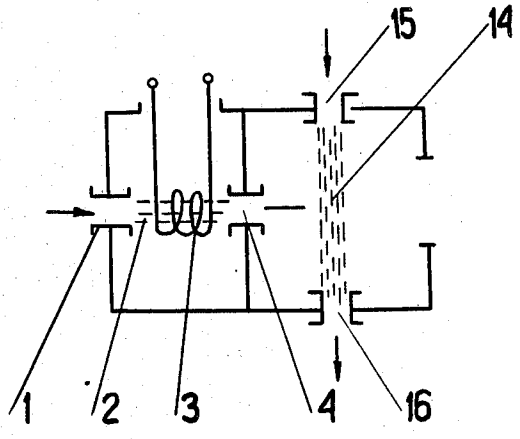


FIG.8

ELECTROPRESSURE JETSTREAM CONVERSION ELEMENT

Heretofore known conversion elements, which convert electric signals into pneumatic or hydraulic signals, have been based on the effects of magnetic or electrostatic influence of electric current. The elements making use of magnetic effects usually have a solenoid core which is movable within the magnetic field of a coil or, a coil which is movable within the field of a permanent magnet, which moving components are used to mechanically vary a fluid jetstream.

The elements making use of the effect of current electrostatic influence are, for example, provided with adequately resilient capacitor plates which disturb the flow of a stream in response to an electric charge imposed on them. The above-described devices, comprising moving parts, have little resistance to shocks and impacts and thus have low reliability in operation.

The inertia of the mechanical moving components results in delay of operation and the potentiality for reducing the dimensions of such devices is limited due to the use of magnets and coils.

It is an object of the present invention to eliminate the above-mentioned drawbacks. This aim has been achieved by employing, in a conversion element, the thermal operation of electric current upon a flowing jetstream.

The present invention provides an electropressure jetstream conversion element which comprises a chamber and one or more inlet ports and outlet ports, and a stationary electroheating element made of electroresistive material of low thermal inertia, the said heating element controlling the signal at the outlet of the conversion element by changing the properties of the jetstream flowing through this conversion element.

The present invention also provides an electropressure conversion element which is completely insensitive to shocks, impacts, changes in position and has a short response time, small dimensions and low weight. Moreover, the present invention element ensures high reliability in operation due to the fact that there are no moving parts in the device.

An embodiment of the invention will now be further described by way of examples, with reference to the accompanying drawings wherein:

FIG. 1 is a diagrammatic illustration of a first embodiment of a conversion element in accordance with the present invention.

FIG. 2 diagrammatically illustrates another embodiment thereof.

FIG. 3 illustrates a conversion element similar to FIG. 2, with a shaped inlet port.

FIG. 4 shows a conversion element in association with a free stream fluid amplifier.

FIG. 5 shows a conversion element in association with an adherent stream fluid amplifier.

FIG. 6 shows a conversion element with a fluid and mechanical system.

FIG. 7 discloses a conversion element with a spindle valve control.

FIG. 8 shows a conversion element forming a part of an amplifier.

FIG. 1 shows an electropressure conversion element which comprises an inlet supply port 1, an outlet tapping port 4 and an electroheating element 3 located between the said ports and being, for instance, a helical element which transfers heat energy to the jetstream of a working medium 2; the medium flowing from the inlet port 1 under a constant feed pressure is heated up by the elements 3 to a temperature depending upon the intensity of current through the said heating element, thus the medium physical parameters are changed due to this heating-up process; in the case the flow parameters are established to be lower than the critical value of Reynolds number, an increase of temperature of the free jetstream is obtained and, in consequence, the pressure at the outlet of the device is decreased; since the effect is continuous in its nature, the device of FIG. 1 provides the analogue conversion of a current signal into a pressure signal.

FIG. 2 shows a device according to the invention which device has an inlet port 1 and an outlet or tapping port 4, and an electroheating element 3 which is a resistance wire stretched through the port 1, the wire having a uniform cross section along its length; the electroheating element 3 can be instead a port 1 either made of, or lined with, an electroresistance material; where the flow parameters of the jetstream which flows from the said port 1 and which is heated up by the heat energy emitted from the said electroheating element, are established to be close to the critical value of Reynold's number, the following change in the values of physical quantities of the said stream results in changing the nature of flow from a laminar into a turbulent one, or inversely, and, in consequence, a vehement pressure change appears at the port 4; this enables the conversion element shown in FIG. 2 to be used as a logic element in pneumatic or hydraulic arrangements of logic and digital systems associated with electric circuits.

FIG. 3 represents an electropressure conversion element in which inlet port 1 is specially shaped, for instance, for subsonic flows and comprises tapered diffusers 11 and 13; electric power is supplied into a cylindrical part 12 of the port 1 by means of a electroheating element 3; the heat energy, emitted during electric current flow through the electroheating element, is converted into the kinetic energy of jetstream 2; any increase of electric signal value results in a rise of the pneumatic or hydraulic signal in an outlet port 4; the element shown in FIG. 3 can be used both as an analogue device or a discrete one.

FIG. 4, FIG. 5, FIG. 6, FIG. 7 and FIG. 8 show some examples of practical applications of the conversion elements described above, in known pneumatic and hydraulic systems of automatics control engineering.

FIG. 4 shows a known fluid amplifier with free jet. A main jet stream 2 flowing from an inlet or supply port 1 to an outlet or tapping port 4 can be blown by the side jetstreams emitted from side or signal input ports 5, and so the main jetstream 2 can be, in this case, disturbed in the same way as it is done in the device shown in FIG. 2 by supplying electric current to an electroheating element 3. Another version of such a device is provided with an electroheating element 3 which is located in the port 5 of a fluid amplifier instead of being placed in the inlet port 1 of the main stream. This arrangement provides a reverse operation of the applied electric signal upon the main jetstream 2.

FIG. 5 shows a known, flat, fluid amplifier with adherent stream. A main jetstream 2 is here thrown over to one of two outlet or tapping ports 4 upon the establishment of supplementary jetstreams in side or signal input ports 5. The main jetstream 2, in this arrangement, can also be thrown over by means of electric energy supplied to an electroheating element 3. The heating element as shown in FIG. 5 is a wire, while in another version of the device of FIG. 5 the element is arranged as a liner coating the device wall.

FIG. 6 presents a device for mechanically increasing a pressure signal. A jetstream 2 emitted from a port 1, in which the said stream is heated by a helical element 3, is used to operate a lever 6 supported at a fulcrum point 7. The lever is used to balance a pneumatic or hydraulic cascade 8 thus resulting in a change of outlet signal which is a cascade pressure 9.

FIG. 7 shows another device which enables not only an outlet pressure but also the power of an outlet signal to be increased. Supplying an electric signal to an electroheating element 3 results in changing the pressure in an outlet port 4 with a constant value of pressure to feed ports 1 and 10 and with the said outlet port being connected to a cylinder inside of which a known spindle valve 9 is fitted and with the other end of the said valve 9 being under a constant reference pressure due to the flow from a port 10, the change in the electric signal results in a change in the outlet fluid from the spindle valve 9.

FIG. 8 presents a device which provides means, without any mechanical moving parts, to amplify the outlet signal developed in a port 4 by using the said outlet signal to modify an additional jetstream 14 which flows from a port 15 being fed with a constant, adequately higher pressure. An amplified outlet signal from the entire device is available in a port 16.

Any electric current parameter, such as intensity, voltage, frequency or other, can be used as the inlet signal in the devices described above.

We claim:

1. An electrostream conversion element comprising:
   a. a chamber having inlet port means and a single outlet port;
   b. means for establishing a single stream of fluid from said inlet port means to said outlet port; and
   c. means for changing the pressure of said stream at said outlet port, said means comprising electroheating means in heat exchange relationship with said stream of fluid upstream of said outlet port.

2. The jetstream conversion element of claim 1, said electroheating means comprising a coil.

3. The jetstream conversion element of claim 1, said electroheating means being a resistance wire extending through said port means,

4. The jetstream conversion element of claim 1, said inlet port means being also said electroheating means.

5. The jetstream conversion element of claim 1, wherein said inlet port means comprises the inlet port of a free stream fluid amplifier, said fluid amplifier having fluid signal input port means directed towards said jetstream downstream of said inlet port means.

6. The jetstream conversion element of claim 1, wherein said jetstream is directed against one arm of a lever, and means for applying a balancing force against a second arm of said lever.

7. The jetstream conversion element of claim 1, and further including spindle valve means, said jetstream being directed into an outlet of said spindle valve means.

8. The jetstream conversion element of claim 1, and further comprising an additional stream at a higher pressure than said jetstream directed transversely thereof, whereby modification of said jetstream results in modification of said additional stream.