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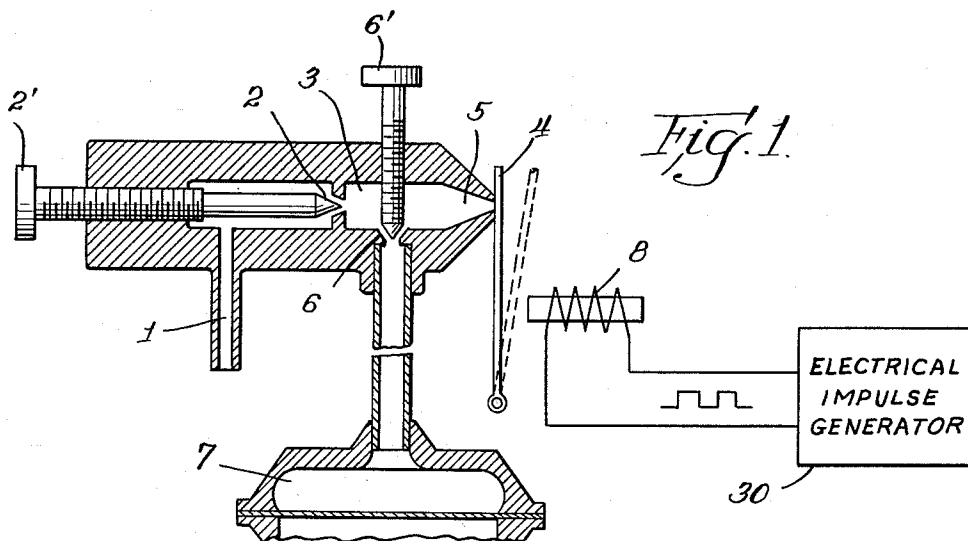
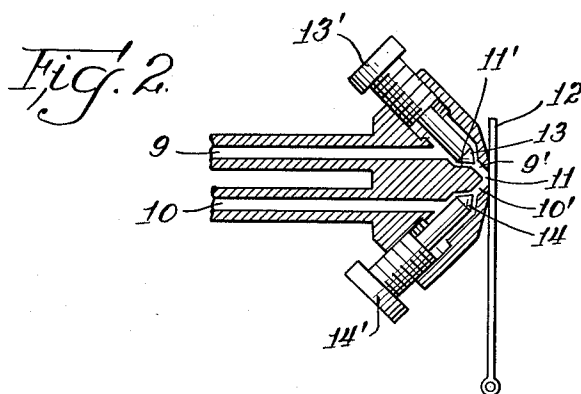
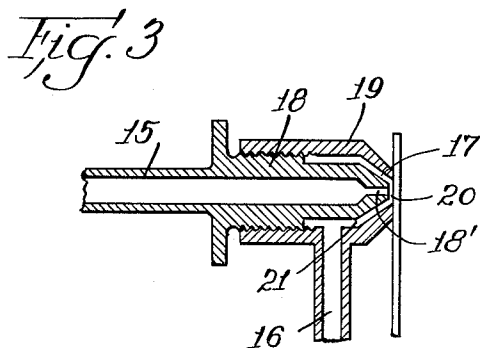
F. RAUFENBARTH

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ELECTRO-PNEUMATIC TRANSDUCER

Filed May 16, 1961

2 Sheets-Sheet 1



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Fig. 5

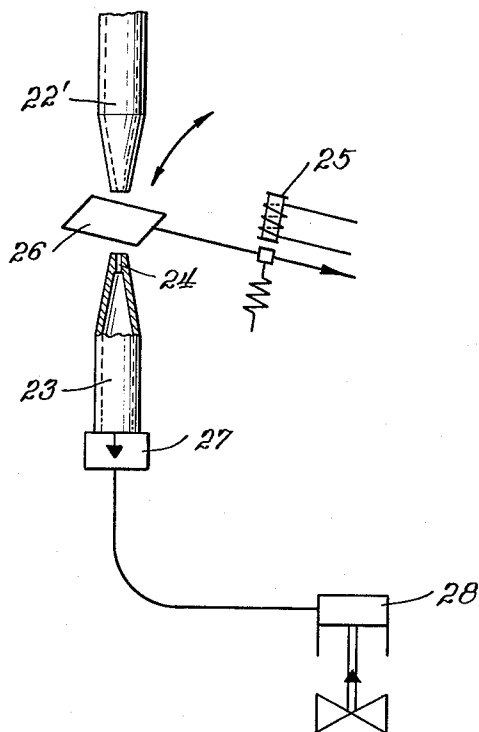
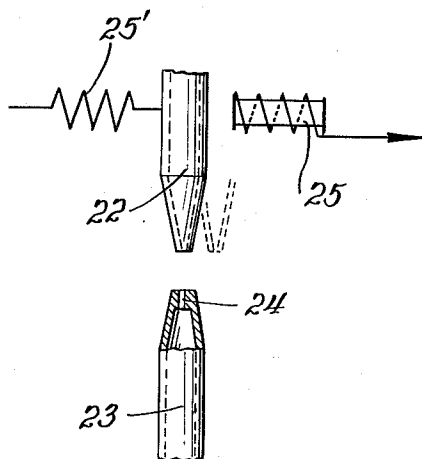


Fig. 4



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ELECTRO-PNEUMATIC TRANSDUCER

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12 Claims. (Cl. 137-82)

This invention relates to an electro-pneumatic transducer for control or regulating purposes. As is well known, such transducers serve to convert electric signals into a corresponding pneumatic working pressure. Continuously operating transducers of this type are well known in the art. They consist of a pneumatic pilot which is under the control of the electric signal and on which the working pressure acts as a negative feed-back. A relatively large electric power is required for such continuously operating transducers.

Electro-pneumatic transducers operating intermittently are well known wherein the electric signal is represented by cyclic impulses of variable duration. Thus a working pressure is obtained which is a function of the impulse ratio. The impulse ratio is the ratio of the duration of the impulse $=t_o$ to the period $=t_o+t_a$, t_a designating that time during which no impulse is present. In a transducer operating with such an impulse ratio control, an alternating or pulsing pressure is produced which becomes effective in the working pressure chamber through a throttle. A mean effective pressure is then obtained within the working pressure chamber which is a function of the alternating pressure and corresponds to the impulse ratio. Up to now, an electro-pneumatic transducer having a working pressure chamber which is connected to an alternating pressure generator through a throttle, so that a mean effective pressure as a function of said alternating pressure is obtained, could be used in practice only for slowly proceeding operations.

For example, the alternating pressure has been under the control of a magnet actuated valve which has been opened and closed in accordance with the impulse ratio, so that a mean effective pressure was obtained in the relatively large working pressure chamber.

As compared with such electro-pneumatic transducers with impulse ratio control which are practically of no use for regulating purposes because of their inertia, the invention consists in that the alternating pressure generator is cyclically actuated by electrical impulses of variable duration at a frequency of more than 10 c.p.s. and is designed in such a manner that its time constant is smaller than 30 milliseconds. The term "time constant" refers to speed or rapidity with which the apparatus reacts in terms of its output to a change in its input.

It has been found that such a high impulse frequency and a correspondingly small time constant can be achieved if the electro-pneumatic transducer is so designed that the air volume subjected to the alternating pressure is very small and practically has no effect at all. Then it is possible to use a relatively small working pressure volume with high alternation frequency, without having to be afraid of cyclic pulses of the working pressure. Thus an electro-pneumatic transducer is obtained having low inertia and working without negative feed-back, and which can, therefore, be operated with relatively low electric powers.

Advantageously, the alternating pressure generator has a very small air volume between an air admission throttle and the throttle of the working pressure chamber, and an outlet nozzle which is opened and closed by a baffle plate actuated by the electric impulses. Provision can be made that the air admission channel and the working pressure channel are throttled by adjustable throttling screws immediately adjacent the outlet nozzle and open together

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into the outlet nozzle oblique to the contact surface of the baffle plate. Then the alternating pressure is produced only within the short channel portions which lie between the throttling screws and the outlet nozzle and enclose a very small air volume.

Such an alternating pressure generator may also be designed in such a manner that the air admission channel and the working pressure channel are provided in two nozzle bodies positioned coaxially one within the other, the inner body of which is provided with a throttling nozzle and forms a throttling annular slot with the wall of the outer nozzle body closely adjacent the outlet nozzle. The alternating pressure is obtained only in a thin disc shaped air volume between the annular slot and the outlet nozzle, which volume is very small.

The invention may, however, be reduced to practice also in that a pneumatic jet pipe is arranged in front of a collecting nozzle designed as the throttling opening of the working pressure chamber, and that the jet pipe acts upon the collecting nozzle in accordance with the electric impulses. The pneumatic jet pipe may be movable between an operating and a dummy position, and may be under the control of an electro-magnet in accordance with the electric impulses. However, also a baffle plate may be positioned between the jet pipe and the collecting nozzle, which is moved in and out in accordance with the electric impulses. This baffle plate has a very small mass and, therefore, is able to follow rather high impulse frequencies of 50-100 c.p.s.

FIG. 1 schematically shows the principle of an electro-pneumatic transducer operating with baffle plate control.

FIG. 2 and FIG. 3 show other embodiments of a transducer of this type.

FIG. 4 and FIG. 5 schematically show transducers having a pneumatic jet pipe.

Referring now to FIG. 1, a compressed-air admission conduit 1 is provided which is connected to a source of compressed air (not shown). The compressed air enters a control chamber 3 through a throttle 2 adjustable by means of a screw 2'. The chamber 3 is connected with a working pressure chamber 7 through a throttle 6 which is adjustable by means of a screw 6'.

The chamber 3 is provided with an outlet throttle 5 which is positioned in front of a baffle plate 4. The outlet nozzle can be opened or closed by the baffle plate 4 depending upon whether the baffle plate is attracted by an electro-magnet 8 or is released. Electro-magnet 8 is connected to a suitable electrical impulse generator 30.

With the outlet nozzle 5 closed, the pressure in control chamber 3 increases until it has reached the value of the pressure prevailing in the compressed-air admission conduit 1 (inlet pressure). With the outlet nozzle 5 open, atmospheric pressure is obtained in chamber 3, if the throttle 2 is so adjusted that less air enters therethrough than can leave through the outlet nozzle 5. Thus, if the outlet nozzle 5 is alternately closed and opened, an alternating pressure is produced in the chamber 3, which is alternating between inlet pressure and atmospheric pressure.

A mean effective pressure is produced thereby in the working pressure chamber because of the throttle 6. This working pressure depends upon how long the inlet pressure period and how long the atmospheric pressure period lasts in the alternating pressure chamber 3. If the outlet nozzle is opened by the baffle plate 4 upon occurrence of an electric impulse at the magnet 8, as shown here, a low working pressure or atmospheric pressure is produced with long impulses or a permanent impulse, respectively, and a maximum working pressure or a pressure equal to the inlet pressure is obtained with short impulses or in the absence of impulses, respectively. Thus, the working pressure is a function of the duration of the impulses fed

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to the magnet 8. The pressure is variable between two extreme values with a dropping characteristic, i.e. the working pressure decreases, if the impulse length increases.

If, however, the electro-magnet 8 is arranged on the other side of the baffle plate 4 so that the outlet nozzle 5 is closed by the baffle plate 4, a rising characteristic is obtained, of course, i.e. the working pressure increases with the impulse length. It is an essential advantage of the transducer described that it can be used optionally with dropping or rising characteristic by means of simple measures without additional expenditure.

It is essential that the closing and opening of the outlet nozzle 5 by the baffle plate 4 is effected periodically at a relatively high frequency of more than ten cycles per second. The time constant for the adjustment of the respective pressure in chamber 3 must, therefore, be very small and must be less than 30 milliseconds. In order to achieve this the air volume of chamber 3 must be very small. This is achieved with the embodiments shown in FIGS. 2 and 3.

Referring to FIG. 2, an air admission conduit or channel 9 is provided, which is throttled by an adjustable throttling screw 13' immediately adjacent the outlet nozzle 11, so that an inlet throttle 13 is formed. In similar manner, a working pressure conduit or channel 10 is throttled by a throttle screw 14' at 14. The channel portions 9' and 10' of the channels 9 and 10, respectively, open into the outlet nozzle 11 oblique to the contact surface of the baffle plate 12. In this embodiment, the control chamber 3 of FIG. 1 has been reduced to the two channel portions 9', 10' so that the alternating pressure is produced only in the small air volume of the channel portions 9' 10' which form a control chamber.

In the embodiment shown in FIG. 3, the air admission conduit 15 is provided in a nozzle body 18 having a throttling opening 18'. The nozzle body 18 is screwed coaxially into a second nozzle body 19 provided with the outlet nozzle 20 which can be closed by a baffle plate. The working pressure conduit 16 is connected to an annular chamber 21 formed between the nozzle bodies 18 and 19. Immediately adjacent the outlet nozzle 20, the annular chamber 21 is narrowed to an adjustable throttling slot 17. The control chamber 3 of FIG. 1 is represented here by a thin disc-shaped air volume which is still present between the throttling slot 17 and the outlet nozzle 20 and forms a control chamber.

In the embodiment of the invention shown in FIG. 4, a pneumatic jet pipe 22 is provided from which compressed air is discharged permanently and at a high flow rate. The jet pipe 22 is tiltably mounted in a manner not shown and can be tilted by an electro-magnet 25 from the operating position shown into a dummy position, shown in dashed lines, against the action of a return spring 25'. In its operating position, the jet pipe acts on a throttling collecting nozzle 24 positioned at the end of a working pressure conduit 23. In its dummy position the jet pipe 22 blows by the collecting nozzle 24. It will be obvious that a mean effective pressure will be produced in the working pressure pipe 23, which, with a cyclic movement of the jet pipe 22, depends on the duration of the operating position as compared with the duration of the periodic movement.

In the embodiment shown in FIG. 5, a baffle plate 26 is provided between the collecting nozzle 24 and a fixed pneumatic jet pipe 22. The baffle plate is movable transversely to the direction of the compressed air jet and serves to cyclically shield the collecting nozzle 24 against the compressed air jet. The working pressure conduit 23 is connected to a working piston 28 through a pneumatic amplifier 27. The piston is used to open or to close a valve. By means of an electromagnet 25, the baffle plate 26 can be brought either into its shielding position or in its dummy position. In the former case, a mean effective pressure decreasing with increasing impulse duration is

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obtained (dropping characteristic). In the latter case the mean effective pressure increases as the impulse duration increases (rising characteristic).

What I claim is:

1. An electro-pneumatic transducer for control and regulating purposes having a working pressure chamber which is connected to an alternating pressure generator through a throttle, so that a mean effective pressure as a function of said alternating pressure is obtained, characterized in that the alternating pressure generator is cyclically actuated by electrical impulses of variable impulse ratio at a frequency of more than 10 c.p.s. and is designed in such a manner that its time constant is smaller than 30 milliseconds.
2. An electro-pneumatic transducer according to claim 1 characterized in that the alternating pressure generator has a very small air volume between an air admission throttle and the throttle of the working pressure chamber, and an outlet nozzle which is opened and closed by a baffle plate actuated by the electric impulses.
3. An electro-pneumatic transducer according to claim 2, characterized in that the air admission channel and the working pressure channel are throttled by adjustable throttling screws immediately adjacent the outlet nozzle and open together into the outlet nozzle oblique to the contact surface of the baffle plate.
4. An electro-pneumatic transducer according to claim 2, characterized in that the air admission channel and the working pressure channel are provided in two nozzle bodies positioned coaxially one within the other, the inner body of which is provided with a throttling nozzle and forms a throttling annular slot with the wall of the outer nozzle closely adjacent the outlet nozzle.
5. An electro-pneumatic transducer according to claim 1, characterized in that a pneumatic jet pipe is arranged in front of a collecting nozzle designed as the throttling opening of the working pressure chamber, and that the jet pipe acts upon the collecting nozzle in accordance with the electric impulses.
6. An electro-pneumatic transducer according to claim 5, characterized in that the compressed air jet pipe is movable between an operating and a dummy position, and is controlled by an electro-magnet in accordance with the electric impulses.
7. An electro-pneumatic transducer according to claim 5 characterized in that a baffle plate is positioned between the jet pipe and the collecting nozzle, which is moved in and out in accordance with the electric impulses.
8. An electro-pneumatic transducer for control and regulating purpose, said transducer including: a working pressure chamber; a throttle connected to said working pressure chamber; and fluid supply means including an electro-magnetic device actuated by electrical impulses having a frequency of more than 10 cycles per second, said means communicating with said throttle to supply fluid under a first pressure to said throttle and thus to said chamber in impulses corresponding to the electrical impulses.
9. A transducer as set forth in claim 8, wherein said throttle is in communication with a pressure substantially lower than the first pressure in the intervals between said impulses.
10. A transducer as set forth in claim 9, wherein the electrical impulses have a variable impulse ratio.
11. An electro-pneumatic transducer for control and regulating purpose in response to an electrical impulse means and in conjunction with a source of fluid under pressure, said transducer including: a working pressure chamber; a throttle connected to said working pressure chamber; a control chamber connected to said throttle, said control chamber having a relatively small volume; a second throttle connected to said control chamber and to the source of fluid to place said source in communication with the control chamber; an opening from the control chamber to atmosphere; a closure member for said

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opening and movable between positions at which the opening alternatively is open and is closed; and electro-magnetic means to move said member between said positions at a frequency of more than 10 cycles per second, said electro-magnetic means being connected to said impulse means to move the member in response to the electrical impulses from said impulse means.

12. A transducer as set forth in claim 11, wherein said throttles are variable.

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