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Fluidic Oscillators with Active Devices Operating in Anti-Parallel

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Abstract: Paper discusses a low-frequency fluidic oscillator consisting of a pair, A and B, of monostable Coanda-effect diverter amplifiers, each with load restrictor of vortex type with variable entrance flow direction. The pair operates in anti-parallel: OPEN regime in A is concurrent with CLOSED regime in B.

Introduction

Development of devices for generation air microbubbles in water became recently of importance especially because of the potential role in production of renewable automobile liquid fuels [1] from unicellular organisms producing biomass by photosynthesis using CO_2 from the supplied air bubbles. An efficient approach eliminating the difficulties of the bubbles being too large was found in pulsating the air supply into the aerator by a fluidic oscillator. The initially small microbubbles nevertheless tended to increase their size by repeated conjunctions while they were still at the aerator exit. A solution was found in retracting each of the newly formed microbubble back into the aerator exit channel for the subsequent part of the cycle [2] – and these complicated bubble and liquid column motions required a lower than originally expected oscillation frequency.

The novel oscillator

Standard design of fluidic oscillators with a jet-deflection amplifier and feedback loop(s) exhibits in this case of low oscillation frequency a number of drawbacks and had to be replaced by a different oscillation generation principle. This paper discusses an oscillator based on the idea of two units — each with an active element and its load restrictor — having their control terminals interconnected so that e.g. the OPEN regime in one active element forces the other element to switch into also the OPEN state, but this generates a control effect reversing the regimes into the CLOSED one.

This is a fluidic version of the electronic *multivibrateur* invented by Abrahan & Bloch in 1919. The vacuum valves of their electronic device [3] is in the discussed new fluidic oscillator [4] replaced by the Coanda-effect jet-deflection diverter amplifiers, Figs. 1 to 3. Instead of charging an accumulation chamber (which would be the direct correspondent to the electric capacitor in [3], the necessary time delay (reversing the phases) is provided by the spin-up of the vortex in vortex-type superquadratic fluidic resistors. Another new and unusual feature of this design is the pre-chamber between the amplifiers and the resistors. In the stable regime, the jet issuing from the supply nozzle of the amplifier is guided into the vortex chamber radially (Fig. 3), passing through it with very low hydraulic resistance. When the jet is deflected by the control flow to other Coanda-attachment wall, its trajectory is bent and entering the chamber tangentially (Fig. 2). The bending increases the resistance and even more effective resistance increase is then provided by the centrifugal acceleration the fluid flow has to overcome so as to get to the exit opening located in the centre of the vortex.

The sequence of schematic representation of flows in Fig. 4 shows at the time instant 1 spinning up taking place in the vortex chamber A concurrent with slowing down in chamber B. At the time 2 the vortex in chamber A blocks the flow there while the chamber B is in the OPEN regime. In the next instant 3 the flow in chamber A is slowing down while in B the rotation rate increases. Finally, in A there is the low-loss radial flow and rotation in B.

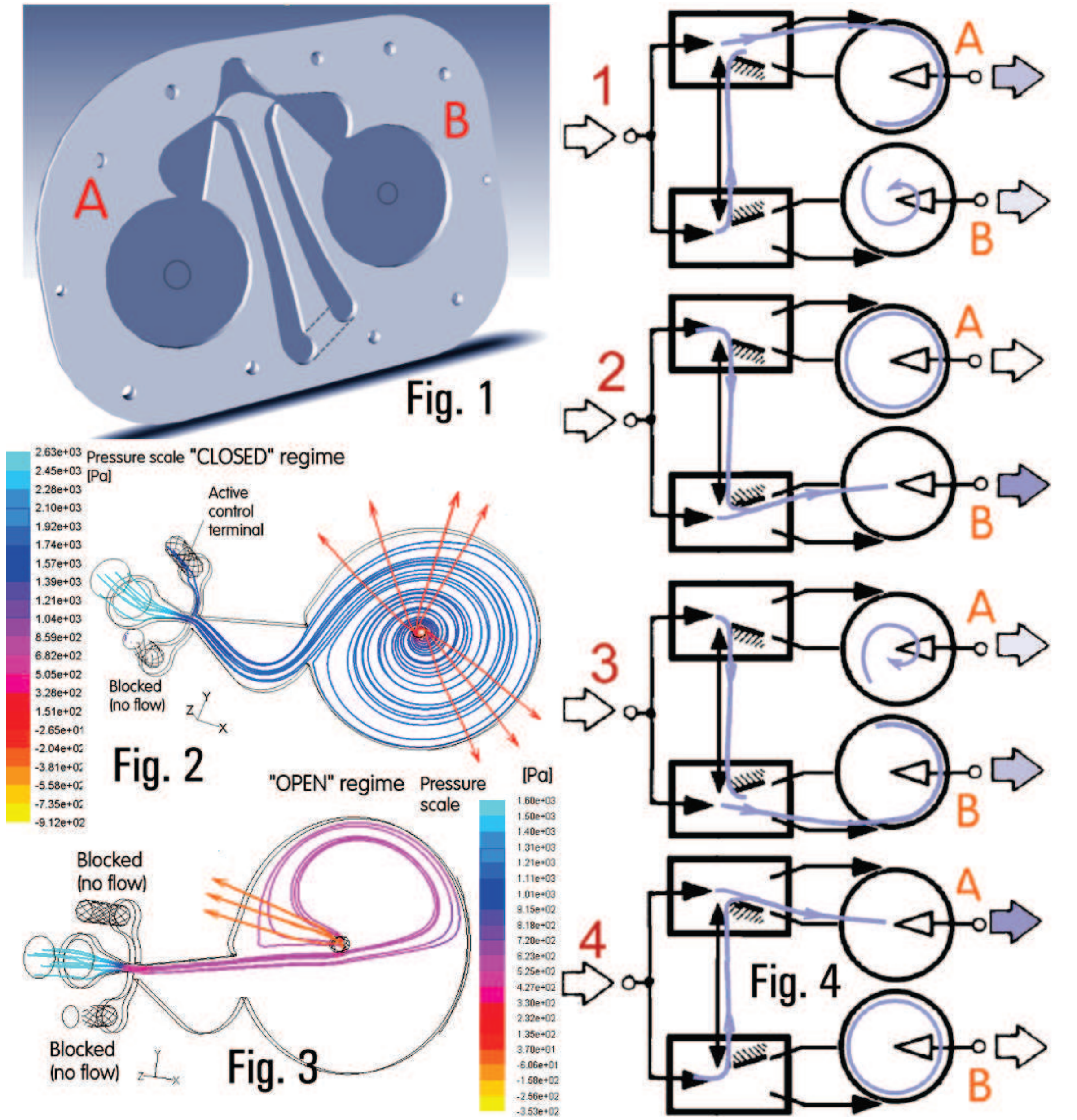

Fig.1: *(Top left)* Vie of the cavities of two Coanda-switched diverters with vortex restrictors operating in anti-parallel. Fig. 2: *(Middle left)* Computed flow in CLOSED regime. Fig. 3: *(Bottom left)* Flowfield in the OPEN regime. Fig 4: *(Right-hand side):* Phases of the anti-parallel operation: OPEN regime in A concurrent with CLOSED regime in B.

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