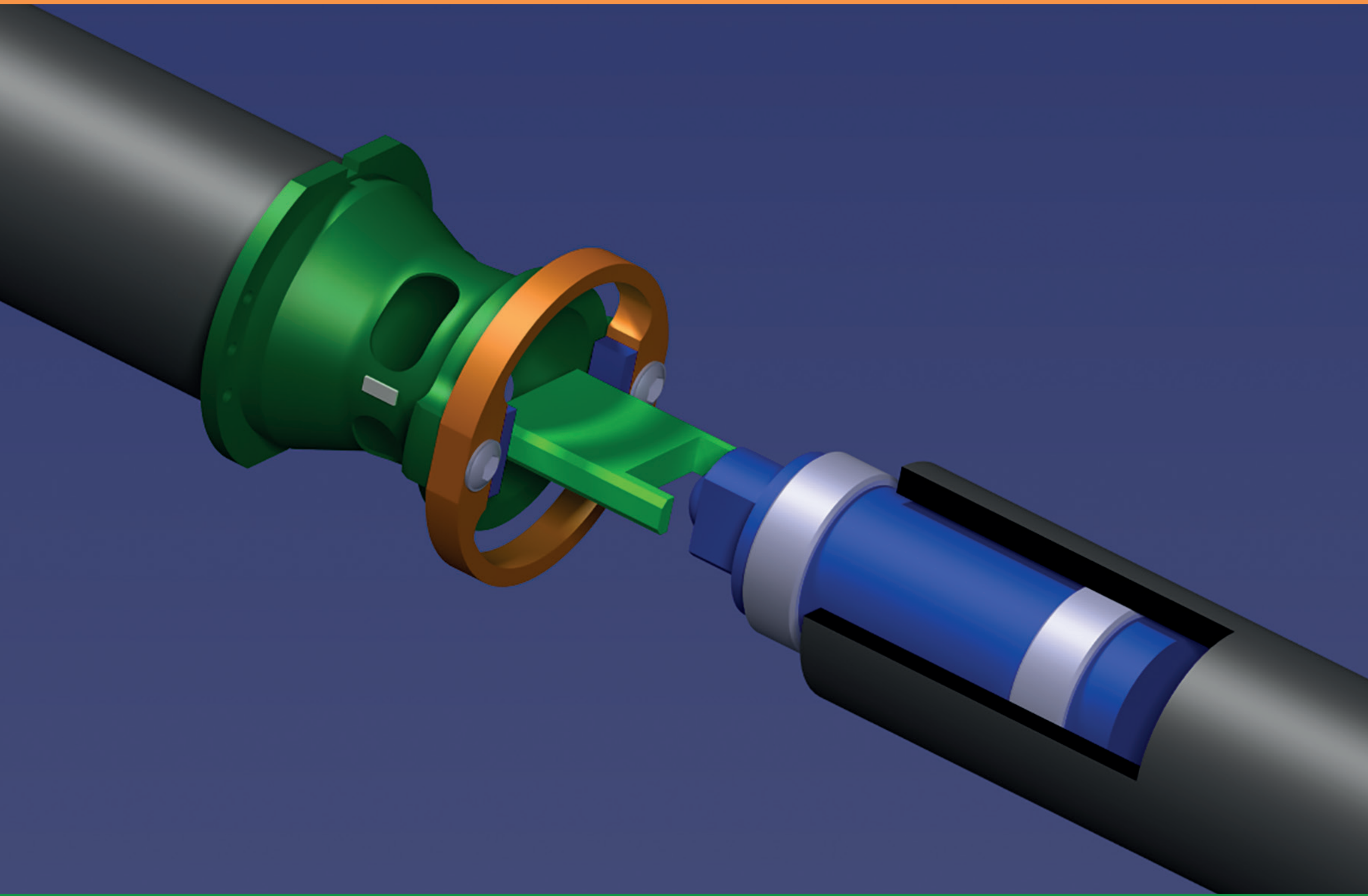
Abstract Book



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Controllable high performance valves for improved crashworthiness of inflatable structures

P Pawłowski, C Graczykowski, M Ostrowski, K Sekuła and A Mróz

Polish Academy of Sciences, Poland

Energy absorbing pneumatic systems are mainly passive devices, which do not present ability of adaptation to various loading conditions. One of the most promising technology allowing for elimination of the abovementioned shortcomings are Adaptive Inflatable Structures (AIS cf. Refs. [1-2]), which form a new, special class of Adaptive Impact Absorption systems [3]. The proposed concept is based on application of compressed gas and controlling its pressure as an effective methodology allowing for adaptation of energy absorbing structures (airbags, fenders, barriers) to actual impact loading. Adaptive Inflatable Structures contain sealed chambers filled with compressed gas and equipped with controllable inflators and discharge valves. Pressure adjustment relies on appropriate initial inflation of particular chambers and control of the gas flow between the chambers and outside the structure during the process of deformation. Appropriate change of the actual value of pressure in different parts of the structure enables adaptation to dynamic loading of various energy, amplitude and location, however fast and efficient valves are required for optimal control. In many cases instead of a real-time control strategy it's sufficient to apply a two stage sequence. At the beginning of the process valve remains closed providing fast rise of the pressure to the desired, optimal level. In the next step the valve opens, and subsequently the valve closes stabilizing the pressure level.

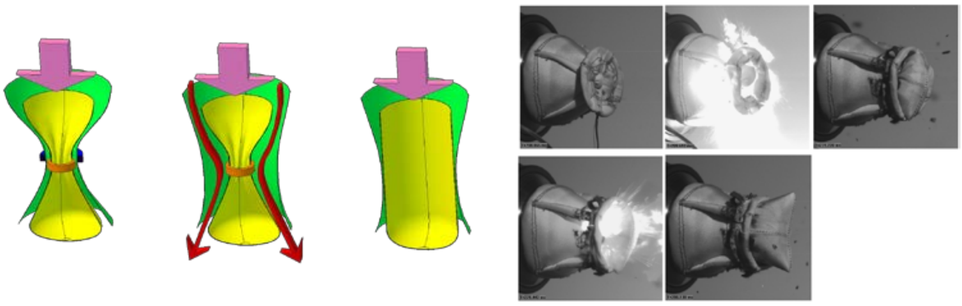

Fig. 1. Principle of operation of the membrane valve and its validation.

The high-performance membrane valve (Fig. 1) is a light valve which serves for fast restricting the fluid flow. The process of controllable opening and closing of the valve takes advantage of the pressure of gas which provokes movement of the membrane elements and generates forces sealing the valve after closing. The operation of the valve is initiated by removing or destruction of two clamping rings e.g. by using technique of electric bridge wire (EBW).

The controllable valve which utilizes bistable snap-through effect (Fig.2) is equipped with two independent elastic shell elements with two stable configurations, which are aligned in the initial configuration such that the flow of the gas is totally blocked. Opening of the valve is performed by a controllable snap-through of the first shell element which causes creation of the flow channel. Closing of the valve is performed by controllable snap-through of the second shell element which causes alignment of the both shells and blocking the gas flow. Recovering the initial configuration may be conducted by controllable snap-back of shell elements.

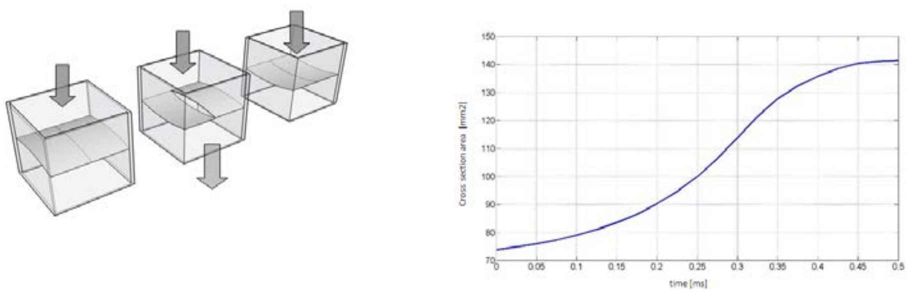

Fig. 2. Principle of operation of the bistable valve; experimental curve of valve's flow channel area vs. time during closing.

The described solutions provide the possibility of fast opening and closing of the valves, which is required for realization of the optimal control strategy for the pneumatic absorbers. The proposed valves are characterized by large mass flow rate of the gas, small total mass and small inertia of the device.

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