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Seismic detection system for blocking the dangerous installations in case of strong earthquake occurrence

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During the last 70 years, four major earthquakes occurred in the Vrancea seismic area affected Romania territory: 10 November 1940 (Mw = 7.7, 160 km depth), 4 March 1977 (Mw = 7.5, 100 km depth), 30 August 1986 (Mw = 7.2, 140 km depth), 30 May 30 1990 (Mw = 6.9, 80 km depth).
Romania is a European country with significant seismicity. So far, the 1977 event had the most catastrophic consequences: about 33,000 residences were totally destroyed or partially deteriorated, 1,571 people dies and another 11,300 were injured. Moreover, 61 natural-gas pipelines were damaged, causing destructive fires. The total losses were estimated at 3 mld. U.S. dollars.
Recent studies clearly pointed out that in case of a strong earthquake occurrence in Vrancea region (Ms above 7), the biggest danger regarding the major cities comes from explosions and fires started immediately after the earthquake, and the most important factor of risk are the natural gas distribution networks. The damages are strongly amplified by the fact that, simultaneously, water and electric energy lines distributions are damaged too, making impossible the efficient firemen intervention, for localizing the fire sources.
Presently, in Romania safe and efficient accepted solutions for improving the buildings securing, using antiseismic protection of the dangerous installations as natural-gas pipelines are not available. Therefore, we propose a seismic detection system based on a seismically actuated gas shut-off valve, which is automatically shut down in case of a seismic shock. The device is intended to be installed in the natural-gas supply line outside of buildings, as well at each user (group of users), inside of the buildings. The seismic detection system for blocking the dangerous installations in case of a strong earthquake occurrence was designed on the basis of 12 criteria enforced by the US regulations for seismic valves, aimed to eliminate the critical situations as fluids and under pressure gases leakage caused by the seismic shocks.
The system is mechanical actuated (no external power sources needed) and consists of two main parts: the element for energy accumulation, i.e. elicoidal spring, and the blocking system for shut-off and secured positioning of the installation. The criteria of the energy accumulating and storing are successfully accomplished by the torsion spring: the exact amount of needed mechanical energy is stored, the certain rotation couple is ensured, the mechanical energy is not influenced by the external factors (temperature, humidity, radiation etc.), the energy stored is time-stable and no energy loss is possible during the operation.
The device is self-functioning, independent of any energy source, and the mechanism used in the locking system is not involving gravitational field; moreover, the blocking down energy is stored and adjustable, being possible to overrun several times the minimum necessary energy needed for locking the system, with a high level of stability. Additionally, the blocking system of the seismic valve remains closed (visibly) until the device is manually unblocked and armed, after a preliminary checking of the full installation functionality. The device conception and execution allow a very stable operation for more than 30 years. Since the fluid is not flowing through the blocking mechanism, the system can be successfully used for: natural gases installations, protection of GPL tanks, corrosive poisonous substances, polluting agents etc.