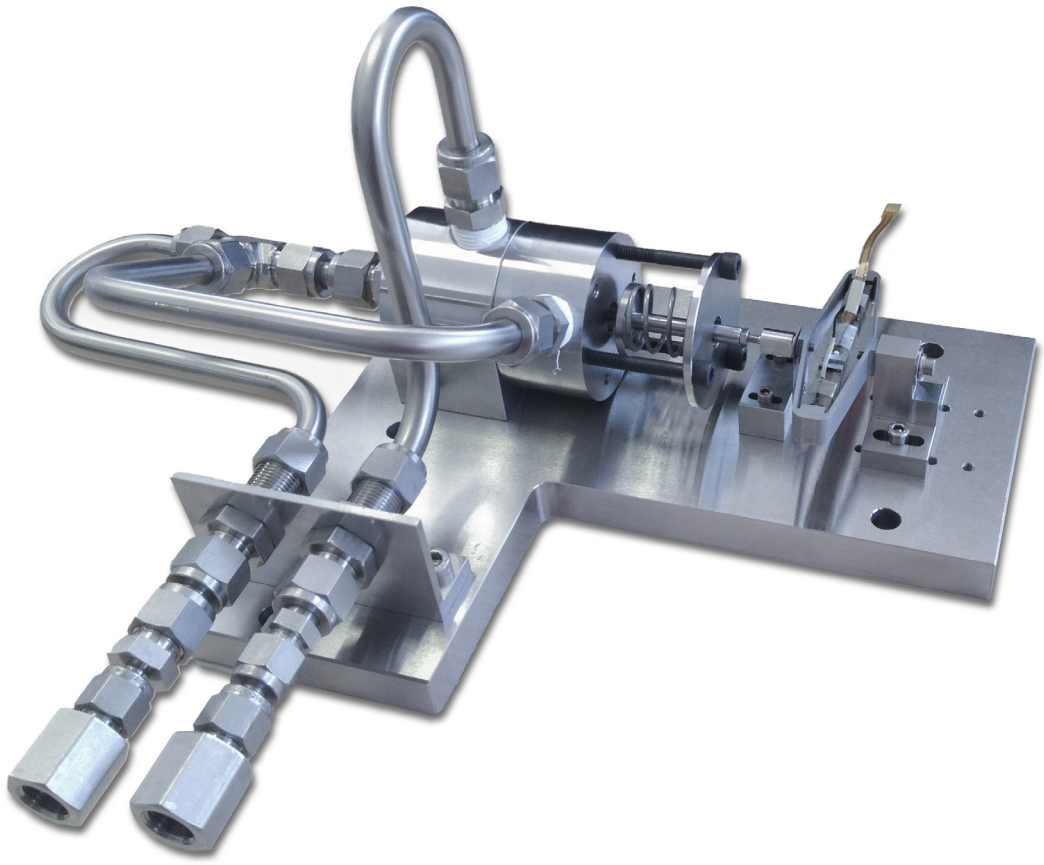
MECHANISMS FOR FLUIDIC APPLICATIONS



CEDRAT TECHNOLOGIES
Innovation in Mechatronics

MECHANISMS FOR FLUIDIC APPLICATIONS

Cedrat Technologies (CTEC) develops mechatronic solutions for demanding environments such as space, optronics, scientific instrumentation...

CTEC offers solutions for fluidic applications such as compressors, pumps and valves with piezo or magnetic technologies. Piezoelectric actuators enable fine control of small flows or very high pressures. Magnetic technologies are available for higher flow rates at low pressures.

1. PROPORTIONAL REGULATION VALVES

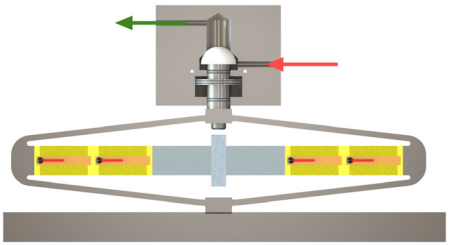


Fig. 1 : Piezo regulation valves principle

Proportional regulation valves achieve very precise flow control regulation, for either flow control or pressure control. In association with a position sensor, located onto the moving part, and a cascaded position / flow control approach, CTEC provides piezo regulation valves compatible with embedded operational environments, featuring vibrations rejection onto the poppet while flowing, to warranty efficient flow control during any transient environment.

Having no joules effects, piezo regulation valves provide no heating, and required no electrical input power, only voltage as a capacitance, which makes piezo valves especially relevant at cryogenic temperatures to generate no parasitic heating on the application.

Compacity of piezo regulation valves makes it very relevant for high pressure, requiring small size housing structure, and small stroke amplitudes to achieve both fine control and high mass flow rates.

1.1. LOW PRESSURE REGULATION VALVE – PIEZO PPV200M

Fig. 2 : Piezo proportional valve PPV200M

This Valves has been designed for cold gases during a TRP project.

This proportional valve has been developed in order to perform fine flow control of pressurized cryogenic temperature gases. The prototype has been tested in lab conditions.

This proportional valve has been developed in order to perform fine flow control of pressurized cryogenic temperature gases.

1.1.1. APPLICATION

Flow regulation, cold gas propulsion, cold gas thrusters.

1.1.2. SPECIFICATIONS

SPECIFICATION	UNIT	VALUE
Flow range	l/min	0.25
Operating upstream pressure	bar	2
Operating temperature	°C	10 to 30

1.2. HIGH PRESSURE REGULATION VALVE - PIEZO

The proportional regulation valve is a variable pressure inlet between 60/200 bar regulating the outlet pressure to 20 and 50 bar.

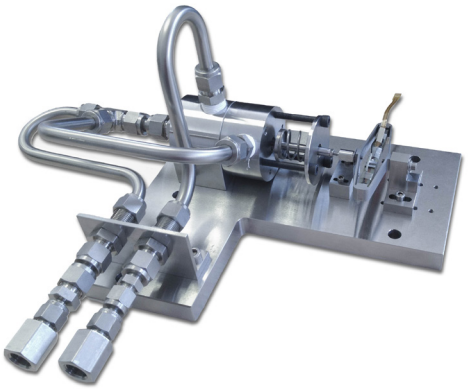


Fig. 3 : 200 Bar high pressure regulation valve

1.2.1. APPLICATIONS

The proportional valve has been developed for high vibration operational conditions as launchers. Vibrations during launch operation conditions are cancelled using internal position control loop based on Strain Gauges sensors.

1.2.2. SPECIFICATIONS

SPECIFICATION	UNIT	VALUE
Input pressure	bar	40 to 200
Output pressure	bar	30 to 70
Flow rate	g/s	15 (Helium)

The project has been founded by the French Space Agency (CNES).

1.3. MAGNETIC REGULATION VALVE

This magnetic actuator has been developed for an ammonia regulation valve mechanism.

Fig. 4 : Magnetic regulation valve

1.3.1. APPLICATION

Pressure flow regulation.

1.3.2. SPECIFICATIONS

SPECIFICATION	UNIT	VALUE
Stroke	mm	3
Force	N	20
Pressure	bar	14
Response time	ms	<10
Temperature	°C	-40 to +80

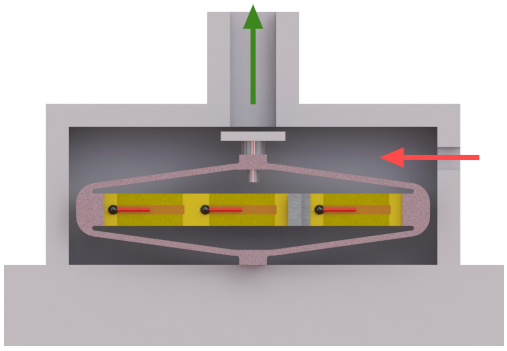


Fig. 5 : Piezo PWM/PJA valve principle

2. PULSE WIDTH MODULATION (PWM) VALVES AND PULSED JET ACTUATORS (PJA)

PWM valves are high frequency on / off valves. The flow control is not achieved by a position regulation of the moving part, but instead by a modulation in time and frequency of a full stroke opening.

Pulsed Jet Actuators (PJA) consists in such piezo valve operation for modern application on Aircraft aerodynamics to supress drag and drift losses on aerofoils, induced by boundary layers flow separation. The PJA needs a pressure source, as an active check valve, which is an alternate approach compared to SJA which generates a pressure wave by itself.

2.1. VIPER PROJECT

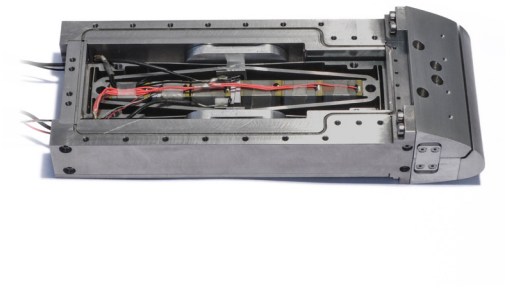


Fig. 6 : VIPER PJA

The VIPER valve was developed in the frame of a Cleansky project. It aimed at developing, manufacturing, and testing piezoelectric valves to accurately control the air flow on transport and business aircraft.

See related publication

2.1.1. APPLICATION

Aeronautics, aerodynamics enhancement (less consumption).

2.1.2. SPECIFICATIONS

SPECIFICATION	UNIT	VALUE
Slot height	mm	1
Slot length	mm	80
Pitch angle of the slot exit	°	30
Exit peak velocity	m/s	340
Exit peak linear mass flow	m/s	425
Actuation max frequency	Hz	500
Dimensions	mm	45x80x210

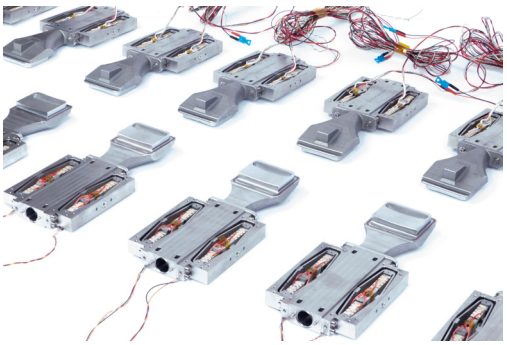


Fig. 7 : Batch of 20 PJA (Pulsed Jet Actuator) used for active flow control in a turbojet engine (ACONIT project)

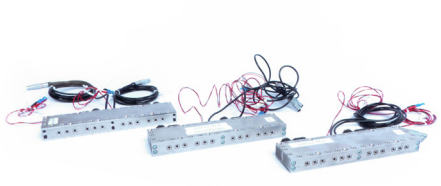


Fig. 8 : Three PJA (Pulsed Jet Actuator) designed to be integrated into a wing for wind tunnel tests (GUGDET project)

3. PRESSURE WAVE GENERATORS (PWG) AND SYNTHETIC JET ACTUATORS (SJA)

Pressure wave generator (PWG) is a reciprocating piezo mechanism actuating on a piston and compression chamber in order to provide a pressure flow oscillation at zero mean flow rate.

Such actuators are commonly used on closed “sealed” volume thermal machines such as refrigerators, or electrical generators based on reciprocating thermodynamic cycles, such as Pulse Tube and Stirling refrigerators and generators, and thermos-acoustic engines.

Open circuit pressure wave generators at ambient Air, based on piezo technology are also especially relevant for Synthetic Jet Actuators (SJA), which is a modern application on Aircraft aerodynamics to suppress drag and drift losses on aerofoils, induced by boundary layers flow separation.

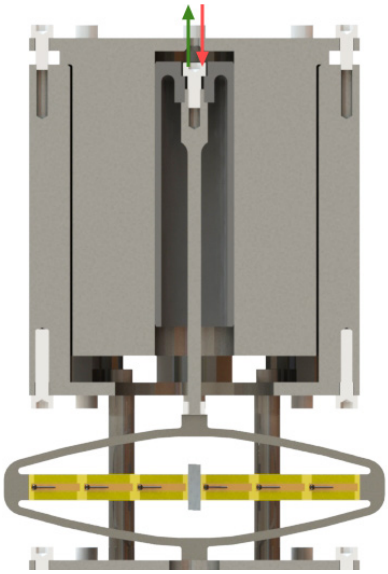


Fig. 9 : Piezo PWG/SJA principle

3.1. ASPIC PRESSURE WAVE GENERATOR (SJA)

ASPIC project aimed at reducing the energy consumption of civil and military aircrafts by adding flow control through synthetic jet actuator.

See related publication

3.1.1. APPLICATION

Synthetic jet actuator for aircraft wings. Increase the aerodynamics performances of the aircraft wings.

3.1.2. SPECIFICATIONS

SPECIFICATION	UNIT	VALUE
Stroke	mm	3
Operating frequency	Hz	260
Piston max speed	m/s	0.38
Active power	W	110
Current peak to peak	A	13
Nominal voltage	V	0 ... +150

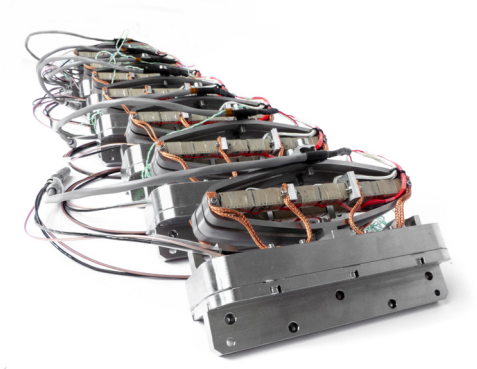


Fig. 10 : Batch of ASPIC SJA mechanisms

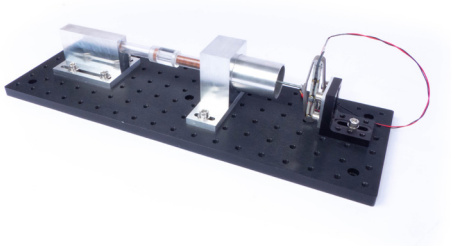


Fig. 11 : Piezo pulse tube stirling refrigerator (demo kit)

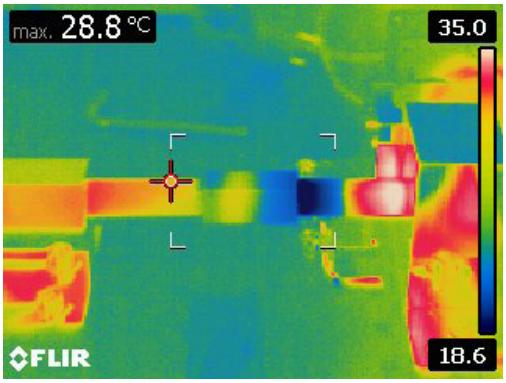


Fig. 12 : Thermal imaging of the pulse tube heat pumping process

3.2. PULSE TUBE STIRLING REFRIGERATOR

Pulse Tube Stirling refrigerator is a heat pumping thermal process, which pumps calories at a given location on a tube, which become the cold tube, and reject it at higher temperature on other location on the tube.

Ambient Air pulse tube in open air circuits can generate cooling thermal gradient with low electrical input power < 10W. Piezo pulse tube allows operation at high frequency 250Hz and very high electrical efficiency > 90%.

High pressure piezo pulse tubes in closed circuit helium gas are especially relevant for 100K-150K temperature cryogenic refrigeration at lower 100Hz – 150Hz frequency operation and 30W – 50W electrical power.

4. REED VALVES COMPRESSORS AND PUMPS

Reed valve compressors are long life compressor dedicated to application requiring zero maintenance other year of continuous operation. Such performance is achieved by designing infinite fatigue life of reed valves together with frictionless reciprocating actuator and piston based on flexure bearing, and gaz bearing.

Reed valves compressors proposed by CTEC are based on Moving Iron Controllable Actuators (MICA) featuring fixed coil and fixed magnet outside the pressure housing, insuring very efficient heat sinking by conduction in embedded environments, as well as no gas contamination by outgazing pollutants. Such featuring makes CTEC reed valves compressors especially relevant for clean gas applications.

Double effect piston concepts together with active control/ synchronisation of two back-to-back actuators insure efficient vibration cancellation and quiet motion. CTEC reed valves compressors are intended for embedded mobility applications such zero boil off of Liquid cryogenic storages of bio-Gaz and Hydrogen, using Joules Thomson liquefaction principle.

Magnetic pumps are of similar actuation principle as per reed valves compressor, making used of commercial check valves or customer advanced fluid diodes and membranes. Piezo based pumps allow compact design and high flow rate thanks to high frequency operation. CTEC Reed valve concept can also be applicable to pumps if static leak tightness at rest is not required.

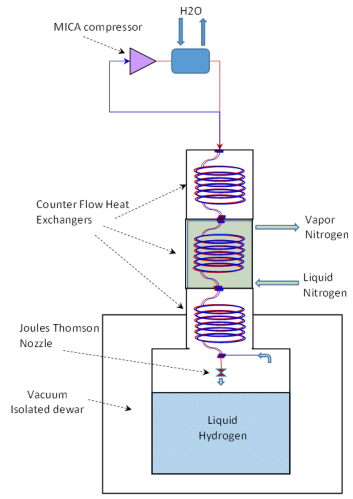


Fig. 16 : Schema principle

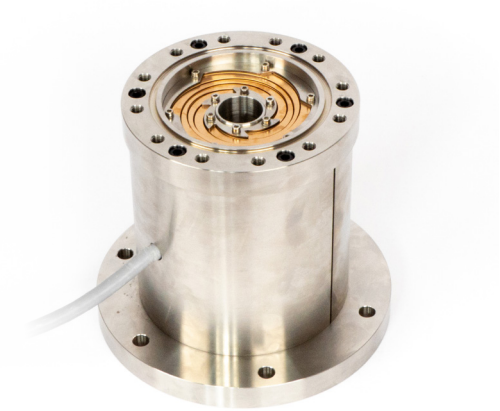


Fig. 13 : MICA300CM actuator for clean gaz compression

4.1. HYDROGEN MAGNETIC JOULES THOMSON REED VALVE COMPRESSOR

In the frame of a TRP project with ESA, a double stage reed valve compressor has been developed. This mechanism is using Moving Iron Controllable Actuators concept (MICA). This actuator is based on magnetic technology.

4.1.1. APPLICATION

The objective of this compressor is to keep liquid hydrogen zero boil off for long duration.

4.1.2. SPECIFICATIONS

SPECIFICATION	UNIT	VALUE
Nominal force	N	360
Peak force	N	670
Nominal constant	N/A	36
Resistance	Ohm	0.4
Mass	Kg	20

Fig. 14 : ESA Hydrogen compressor

4.2. MAGNETIC PUMP

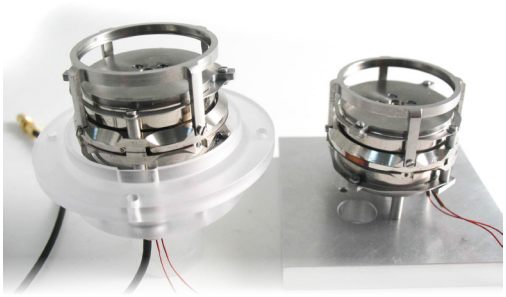


Fig. 15 : Heart assistance pump actuator

In the frame of the CORWAVE project, a specific compact and high frequency magnetic actuator has been developed.

4.2.1. APPLICATION

Blood pump, compact fluid pump.

4.2.2. SPECIFICATIONS

SPECIFICATION	UNIT	VALUE
Volume	mm	35x20
Force	N	20
Operating frequency	Hz	50 to 150
Power	Hz	20

CEDRAT TECHNOLOGIES (CTEC) offers off-the-shelf mechatronics products including piezoelectric & magnetic actuators, motors, mechanisms, transducers and sensors with corresponding drivers & controllers. These mechatronics products are used for scientific and industrial applications requiring fonctions such as: micro and nano positioning, generation of vibrations, micro-scanning, fast & precise motion control, active control of vibrations, and energy harvesting

Most of the products are available in OEM versions for low cost and high volume industrial applications. CTEC also offers services including, design, R&D under contract and training

You can request our e-catalogue on
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CTEC is a SME located in Meylan, Inovallée, the French Innovation Valley near Grenoble. CTEC is recognised as a highly innovative company and has received several awards

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