TECHNICAL REPORT

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Compressors — Classification — Complementary information to ISO 5390

Compresseurs — Classification — Information complémentaire à l'ISO 5390

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Foreword

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In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 12942 was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 6, *Air compressors and compressed air systems*.

Introduction

Classification and terminology standards are fundamental to the identification of a product for using in industrial and trade communications, education, information search, data processing, research, development, inventing, patenting, etc. It is intended that these standards be based on the latest technical achievements and classification theories, cover all viable modern equipment design types, exclude ambiguity, be adapted to easy translations into different languages by exact terms, and be flexible and open to new innovations. This Technical Report is intended to contribute essentially to obtaining these aims for a possible subsequent revision of ISO 5390.

The main modern problems in compressor classification and terminology are associated with rapid development and implementation of new design types. In addition, many manufacturers include in a single non-separable compressor package, not only an aftercooler, but also a receiver, dryer, etc.. In these conditions, it is important to establish and maintain unified patterns and principles for forming new derivative and composed terms by using a few basic original terms as well as using, as far as possible, established professional terms which have emerged spontaneously.

The problems related to the classification of compressor equipment are complicated by the wide spectrum and diversity of application fields, resulting in a great number of applicability and performance criteria, such as:

— compression principles;

— basic design features;

— energy forms used (electricity, fuel heat, etc.) and driver types;

— cooling agents (air, water, etc.) and methods;

— lubrication conditions (oil-free or contaminated with oil);

— mobility, transportability;

— prefabrication level (packaged and factory-assembled compressor, compressor plant, etc.);

— operation modes and service parameters;

— range of functions (compression, energy conversion, cooling, drying, etc.) and appropriate structural composition of the equipment.

Neither identification of the compressor equipment and its application fields nor selection of compressors for specific services and comparison of their technical and economical parameters are possible without knowledge of this information. That is why it is intended that the attributes listed in this Technical Report serve as a basis for the practical multi-dimensional classification system of compressor equipment.

Some explanatory notes and methodical approaches are presented in Annex A.

Compressors — Classification — Complementary information to ISO 5390

1 Scope

This Technical Report gives a classification of modern compressor types and their definitions.

This Technical Report presents terms for use in technical and contractual specifications, manufacturer's literature, information searches and data processing systems, patent information, educational publications for students, service and maintenance instructions, industrial statistics and market surveys, as well as in design, quality, safety, testing and other standards, norms, regulations and codes.

It is intended that adequate technical and economical comparison and evaluation of compressor alternatives for specific application conditions be performed with identical functional, mobility, service pressures and service media classes, as well as with equal capacity ratings.

2 Design classes

2.1 General

The general hierarchy of compressor design classes is given in Figure 1.

Design classes specify the basic working principles and conceptual engineering philosophy of modern compressors being operated, marketed, manufactured, developed, investigated or invented. The classification tables in 2.2 to 2.5 contain preferred terms of basic compressor classes, their definitions and graphical illustrations. Graphical materials are presented only as examples. Non-preferred synonyms are given in parentheses. Special definitions are not given for those subclasses where the wording of the terms characterizes sufficiently basic design features and attributes of the compressor types. More general high-level terms can be used in the technical documentation instead of low-level particular subclasses, such as "compressor", "compressor plant" and "compressor equipment" after the first full description of functional and design subclasses, and in all those cases where there is no possibility of confusion with other subclasses or there is no need to differentiate between specific subclasses.

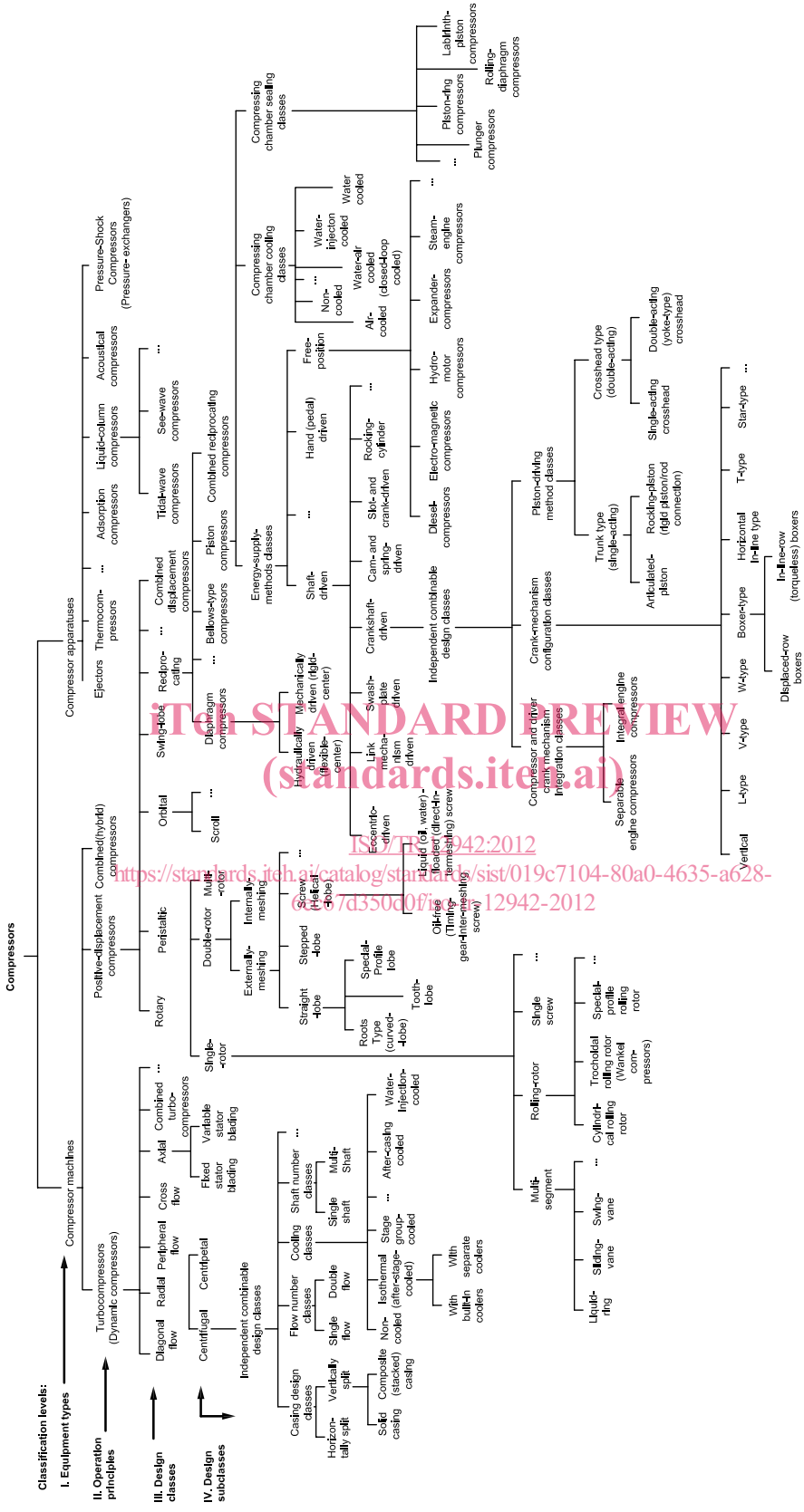
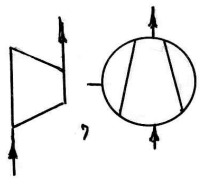
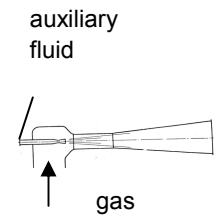
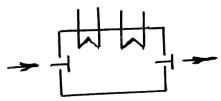
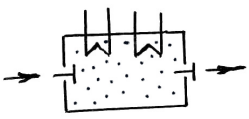


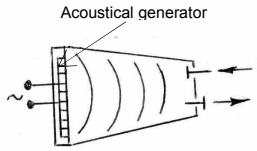
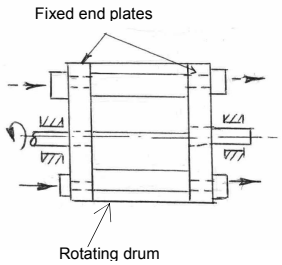
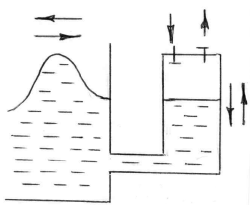
Figure 1 — Design classes of compressors

2.2 Classification by equipment type

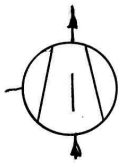
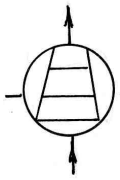
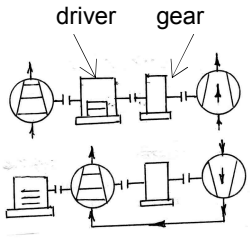
Class, term	Subclass and definition		Illustration (example only)
Compressor (generic term)	A machine or apparatus converting different types of energy into the potential energy of gas pressure for displacement and compression of gaseous media to any higher pressure values above atmospheric pressure with pressure-increase ratios exceeding 1,1. NOTE 1 Similar equipment with pressure-increase ratio values of up to 1,1 is regarded as ventilator.		
	Compressor machine	A compressor in which conversion of different types of energy into the potential energy of gas pressure is effected by mechanical motions of solid working members. NOTE 2 In some design types of compressor machine, intermediate liquid service media can be used for driving-force transmitting from one solid member to the other one (e.g. in electrically/hydraulically driven piston and diaphragm compressor).	See 2.3 to 2.5 for specific classes
	Compressor apparatus	A compressor in which conversion of different types of energy into the potential energy of gas pressure is effected by stationary positions of working members effecting basic energy conversion functions, mechanical motions being used only for auxiliary functions, such as gas inlet and outlet, and energy-agent supply and withdrawal.	See 2.3 to 2.5 for specific classes

2.3 Classification of compressor apparatuses by operation principles

Class, term	Subclass	Definition	Illustration (example only)
Compressor apparatus	Ejector	A compressor apparatus of dynamic type, comprising suction chamber, cylindrical throat and diffuser, in which the gas-pressure increase is obtained in continuous flow by initial increasing its kinetic energy by mechanical action of the motive high-velocity auxiliary fluid stream entraining the gas into the accelerating mixed stream, and successive conversion of the kinetic energy into the potential energy of the mixture pressure by deceleration of the mixture flow in the diffuser, the high velocity of the motive auxiliary-fluid steam being created by its expansion in the nozzle from pressurized state to the initial or lower pressure of the gas being compressed.	
	Thermo-compressor	A compressor apparatus of displacement type in which the gas pressure increase, its discharge and gas intake are obtained by cyclically heating and cooling of the closed volumes of the gas.	
	Adsorption compressor	A compressor apparatus of displacement type in which the gas pressure increase, its discharge and gas intake are obtained by cyclical adsorption of the gas by special adsorbents such as metal hydrides and its desorption at higher pressures by changing temperature conditions.	

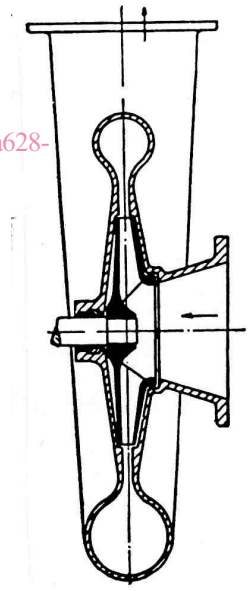
Class, term	Subclass	Definition	Illustration (example only)
Compressor apparatus (continued)	Acoustical compressor	A compressor apparatus of displacement type in which the gas pressure increase, its discharge and gas intake are obtained by cyclical formation of low- and high-pressure phases in the closed volumes of the gas due to actions of pressure waves emitted by an acoustical generator	
	Pressure – shock compressor (Pressure exchanger)	A compressor apparatus of displacement type in which the compression of successive volumes of the gas is effected by shock waves created by the second high-pressure energy-carrying gas in several longitudinal through channels arranged circumferentially on the cylindrical drum, these channels being cyclically closed by rotation of the drum between fixed end plates having inlet/outlet ports and blind zones, the shock waves being generated by cyclical exposure of channel ends to the energy-carrying-gas manifold, and inlet/outlet of both fluids being achieved by synchronization of drum-rotating speed in respect to the fixed inlet/outlet ports with the velocity of pressure-wave propagation. NOTE 1 The rotating drum is not imparting any energy to the gas to be compressed. Its rotation synchronized with shock wave velocity is an auxiliary movement only ensuring control of fluid flows. The drum can be driven by an small auxiliary prime mover or any other power transmitting shaft. NOTE 2 The shock-wave propagation from one channel end to another one and gas compression up to pressure equalization of two fluids in the channels occur essentially faster than mixing of fluids.	
	Liquid-column compressor	A compressor apparatus of displacement type in which admission and compression of successive volumes of the gas are performed periodically by forced expansion and diminution of a closed space(s) in the vertical casing of any form due to displacement of the auxiliary-liquid column in said casing. NOTE 1 The displacement of the auxiliary-liquid column can be generated by external renewable natural-energy sources, e.g. water waves. NOTE 2 The liquid-displacement source subclasses are: — sea-wave driven compressors; — tidal-wave driven compressors.	

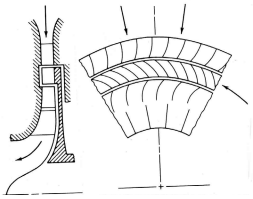
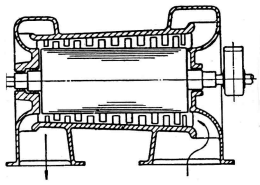
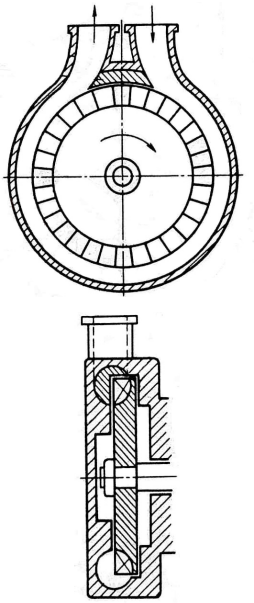
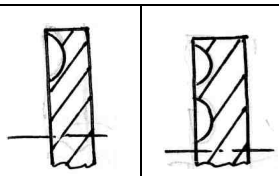
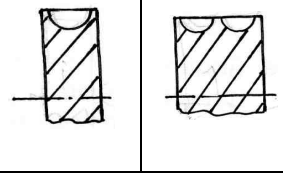
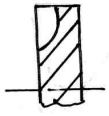
2.4 Classification of compressor machines by operation principles

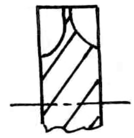
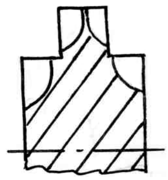
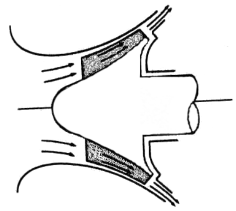
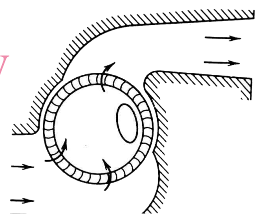
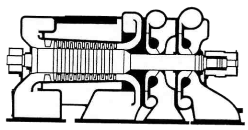
Class, term	Subclass	Definition	Illustration (example only)
Compressor machine	Dynamic compressor, turbocompressor	A compressor machine in which the gas pressure increase is achieved in continuous flow essentially by increasing its kinetic energy in the flow path of the machine due to acceleration to the high velocities by mechanical action of blades placed on a rapid rotating wheel and further transformation of the kinetic energy into the potential energy of the elevated pressure by successive deceleration of the said flow.	
	Positive-displacement compressor	A compressor machine in which the admission and compression of successive volumes of the gaseous medium are performed periodically by forced expansion and diminution of a closed space(s) in a working chambers(s) by means of displacement of a moving member(s) or by displacement and forced discharge of the gaseous medium into the high-pressure area. NOTE The closed spaces with variable or displaceable volumes represent compression chambers. In one working chamber, there can be one or several variable-volume compression chambers.	
	Combined compressor machine	A compressor machine in which the compression of gaseous medium or media is performed simultaneously or successively by dynamic and positive-displacement compressors driven by a common prime mover.	Simultaneous compression  Successive compression

2.5 Design classes of compressor machines

2.5.1 Design classes of turbo compressors (dynamic compressors)

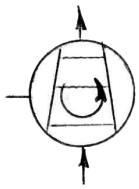
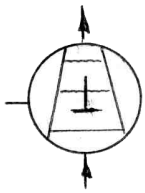
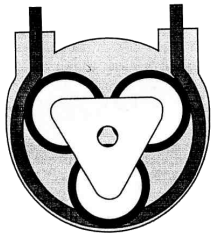
<table>
<tr><th>Class, term</th><th>Subclass</th><th colspan="2">Definition</th><th>Illustration (example only)</th></tr>
<tr><td rowspan="2">Turbo compressor</td><td rowspan="2">Radial turbo-compressor (Radial-flow turbo-compressor)</td><td colspan="2">A turbo compressor in which the acceleration of the gas stream in the meridional plane is performed in radial direction with respect to the axis of rotation of the bladed wheel.
NOTE 1 The subclasses of radial compressors are:
— radial centrifugal compressor;
— radial centripetal compressor.
NOTE 2 The broader term “radial compressor” can be used instead of “centrifugal compressor” if there is no possibility of confusion with centripetal radial compressors.</td><td></td></tr>
<tr><td>Centrifugal compressor</td><td>A radial turbo compressor in which the acceleration of the gas stream is caused essentially by centrifugal forces and performed from the centre of the rotating wheel to its periphery.
NOTE 3 The basic specific subclasses of the centrifugal compressors are:
a) flow-number classes of the rotating wheel:
1) single-flow compressor;
2) double-flow compressor;
b) casing-design classes:
1) horizontally split compressor;
2) vertically split compressor with solid casing;
3) vertically split compressor with stacked casing;
c) cooling-configuration classes:
1) non-cooled compressor;
2) isothermal (after-stage-cooled compressor):
a) with built-in coolers;
b) with separate coolers;
3) stage-group-cooled (sectionally cooled) compressor;
4) after-casing cooled compressor;
5) water-injection-cooled compressor;
d) shaft-number classes:
1) single-shaft compressor;
2) multi-shaft compressor.
NOTE 4 Gas cooling system is a component part of the aggregated compressor equipment (compressor plant); however, in spite of this gas cooling methods influence also essentially the design of the compression mechanism (mechanical compressor).</td><td>  </td></tr>
</table>

<table>
<tr><th>Class, term</th><th>Subclass</th><th colspan="3">Definition</th><th>Illustration (example only)</th></tr>
<tr><td rowspan="4">Turbo compressor (continued)</td><td>Radial turbo-compressor (Radial-flow turbo-compressor) (continued)</td><td>Centripetal compressor</td><td colspan="2">A radial turbo compressor in which the gas stream is accelerated essentially by centripetal forces induced by mechanical action of blades placed circumpherentially on the rotating wheel and moves from its periphery to the centre.</td><td>  </td></tr>
<tr><td>Axial compressor (axial-flow compressor)</td><td colspan="3">A turbo compressor in which the acceleration of the gas stream in the meridional plane is performed in the direction parallel to the axis of rotation of the bladed wheel.
NOTE 5 The basic design subclasses of axial compressor are:
— compressors with fixed stator blading;
— compressor with variable stator blading.</td><td>  </td></tr>
<tr><td>Peripheral flow compressor (periflow compressor, vortex compressor, regenerative compressor, drag compressor, tangential compressor)</td><td colspan="3">A turbo compressor in which the acceleration of the gas stream is performed by its composed resulting motion in peripheral (circumferential) direction in respect of the axis of rotation of the bladed wheel.
NOTE 6 The resulting peripheral motion with helical screw-type flow pattern of the gaseous medium is composed of the radial motion in the rotor pockets under the centrifugal forces, the circulatory motion in the ring-shaped peripheral stator channel caused by centrifugal pressure gradient superimposed by the circumferential motion induced by rotation of the wheel.
NOTE 7 The basic subclasses of peripheral-flow compressors according to configuration and location of bladed rotor channels are:</td><td>  </td></tr>
<tr><td></td><td>a) side-channel compressor</td><td>1. single-side-channel compressor
2. multi-side-channel compressor</td><td rowspan="3">Individual definitions are not necessary because the wording of the terms characterizes sufficiently basic design features of the subclasses.</td><td>  </td></tr>
<tr><td></td><td>b) peripheral-channel compressor</td><td>1. single-peripheral channel compressor
2. multi-peripheral channel compressor</td><td>  </td></tr>
<tr><td></td><td colspan="2">c) angle-channel compressor</td><td>  </td></tr>
</table>

Class, term	Subclass	Definition	Illustration (example only)
Turbo compressor (continued)	Peripheral flow compressor (periflow compressor, vortex compressor, regenerative compressor, drag compressor, tangential compressor) (continued)	d) double-angle-channel compressor	
		e) stepped-channel compressor	
	Diagonal-flow compressor (mixed-flow compressor)	A turbo compressor in which the acceleration of the gas stream in the meridional plane is performed at acute angles between axial and radial directions to the axis of rotation of the bladed wheel.	
	Cross-flow compressor (transverse-flow compressor, diametrical compressor)	A turbo compressor in which the acceleration of the gas stream is performed in diametrical, cross-direction with respect to the axis of rotation of the bladed wheel thus action of two blade rows on the stream is achieved. NOTE 8 Fixed deflectors can be used inside the bladed wheel for better flow guidance between two rows of blades.	
	Combined turbo-compressor	A turbo compressor in which the compression of gaseous medium or media is performed simultaneously or successively in different types of turbo compressors driven by a common prime mover. NOTE 9 Subclasses of combined turbo compressors can be: — axial-radial turbo compressor; — diagonal-radial turbo compressor; — radial-peripheral turbo compressor, etc.	

2.5.2 Design classes of positive displacement compressors

2.5.2.1 General

Class, term	Subclass	Definition		Illustration (example only)
Positive displacement compressor	Rotary compressor	A displacement compressor in which gas admission and diminution of its successive volumes or its forced discharge are performed cyclically by rotation of one or several rotors in a compressor casing. NOTE 1 The rotor-number subclass are: — Single-rotor compressor, — Double-rotor compressor, — Multi-rotor compressor.		
	Reciprocating compressor	A displacement compressor in which gas admission and diminution of its successive volumes are performed cyclically by straight-line alternating movement of a moving member(s) in a compression chamber(s). NOTE 2 Design subclasses of reciprocating compressors are: — piston compressor; — diaphragm compressor; — bellows-type compressor.		
	Peristaltic compressor	A displacement compressor in which admission of the gas volumes and their forced discharge are performed cyclically by local squeezing of sections of a flexible pipe rested on arc-shaped support by rollers of an external rotor and by displacing the trapped gas volumes from low-pressure side to high-pressure area. NOTE 3 The inner flexible-pipe surface driven by the rollers represents the working member in the peristaltic compressors.		
	Orbital compressor	A displacement compressor in which gas admission and diminution of their successive volumes are performed cyclically by plain-parallel non-rotating orbital motion of the working member along the circular or other closed-curve path in the working chamber. Subclass: scroll compressor		
		Scroll compressor	An orbital compressor in which closed-space compression chambers are formed between two identical spiral bands inserted eccentrically in each other and their flat end cover plates, the volumes of said spaces being cyclically decreased and increased from periphery to the centre by orbital non-rotating plane-parallel motion of one spiral band inside the fixed one along the circular path.