

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number:

0 389 036
A1

(12)

EUROPEAN PATENT APPLICATION

(21) Application number: **90200581.8**

(51) Int. Cl.⁵: **F04C 29/00, F04C 18/16**

(22) Date of filing: **09.03.90**

(30) Priority: **21.03.89 NL 8900694**

(43) Date of publication of application:
26.09.90 Bulletin 90/39

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

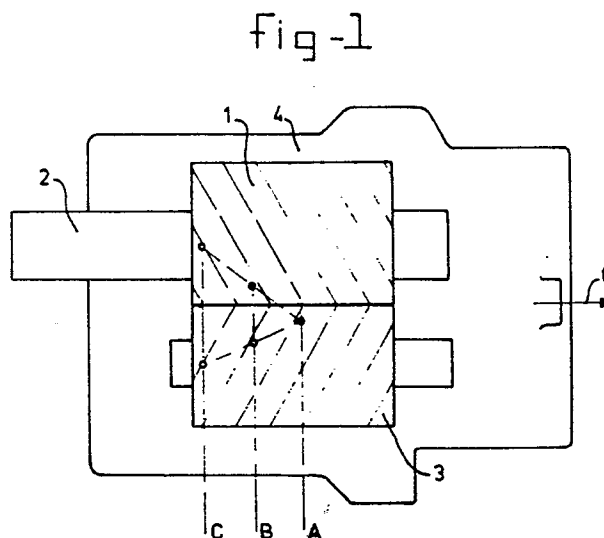
(71) Applicant: **Grass-Air Holding B.V.**
Galliersweg 27
NL-5349 AT Oss(NL)

(72) Inventor: **Jantzen, Hans Hendrik**
Maasdijk 90
NL-5317 KS Nederhemert(NL)

(74) Representative: **de Bruijn, Leendert C. et al**
Nederlandsch Octrooibureau
Scheveningseweg 82 P.O. Box 29720
NL-2502 LS 's-Gravenhage(NL)

(54) **Screw compressor and method of operation thereof.**

(57) Screw compressor with two parallel screws (1,3) engaging with each other, one of which (1) is driven while the other (3) is carried, surrounded by a stator housing (4) and provided with an inlet for the gas to be compressed and an outlet for the compressed gas, said stator housing also having injection points through which water is injected into the stator housing, whereby one injection point (A) is located at a place in the stator housing where the pressure is equal to $2^3\sqrt{P}$ plus or minus 0.5 bar, and in that further injection points (B) are provided at a place in the stator housing (4) where the pressure is equal to $3\sqrt{P}$ plus or minus 0.5 bar and injection points (C) at the inlet side of the gas, P being equal to the absolute final pressure of the compressor.



EP 0 389 036 A1

Screw compressor and method of operation thereof.

The invention relates to a screw compressor with two parallel screws engaging with each other, one of which is driven while the other is carried, surrounded by a stator housing and provided with an inlet for the gas to be compressed and an outlet for the compressed gas, said stator housing also having at least one inlet through which water is injected into the stator housing, and to a method of operation thereof.

Such a compressor and method is known from US Patent Specification 3,535,057, in the embodiment described in Col. 6, lines 29 and 30, i.e. the embodiment without mechanical coupling between the two rotors.

In the known compressor and method, water only is injected at one point, i.e. near the outlet for the compressed gas.

The purpose of the water injection is to lower the temperature of the compressed gas and make it as far as possible the same as the inlet temperature of the gas, in particular air.

It is not stated anywhere in this patent specification that, due to the injection of water, the mechanical coupling between the rotors can also be omitted. Nor are any instructions given concerning the quantity of water to be injected and its temperature.

This suggestion, which was already made in 1968, has never been successful in practice. In practice, compressors working without mechanical coupling virtually all have oil injection. This oil is then used for lubricating, sealing and cooling of the compressor. After compression, this oil must be carefully removed from the compressed gas, generally air, using expensive oil separators, because the presence of oil in any kind of pneumatic device is disastrous.

A so-called oil-free compressor therefore has great advantages, but no practical embodiments are known in practice.

The object of the invention is to produce a compressor and a method of operation thereof by means of which it is in fact possible to obtain isothermal compression economically with water injection alone, provided that a number of conditions are met.

The screw compressor according to the invention is characterized in that said injection point is located at a place in the stator housing where the pressure is equal to $2 \sqrt[3]{P}$ plus or minus 0.5 bar, and in that further injection points are provided at a place in the stator housing where the pressure is equal to $\sqrt[3]{P}$ plus or minus 0.5 bar and at the inlet side of the gas, P being equal to the absolute final pressure of the compressor.

The water therefore has to be injected simultaneously at several, very specific points.

The method according to the invention is characterized in that the quantity of water injected per unit time is between 1% and 2% of the capacity of the compressor, and the temperature of the injected water is at least 5 K lower than the temperature of the gas at the inlet of the compressor.

Through these measures a considerable improvement is obtained in the power which is needed to drive the compressor.

The invention will be explained in greater detail with reference to schematic drawings, in which:

Fig. 1 is a longitudinal section of a conventional screw compressor, in which one screw or rotor is driven and the other is carried;

Fig. 2 is a view from the rear end of Fig. 1.

The compressor, which is conventional per se, comprises a screw 1 with a driving shaft 2.

A screw 3 is in engagement with said screw 1 and in operation is carried by the screw 1. There is no mechanical coupling between the two screws or rotors.

The screws 1 and 3 are supported in and enclosed by a stator housing 4.

The gas to be compressed is fed in at the lefthand side of the housing 4, through a transverse feed 5 (see Fig. 2).

The compressed gas is discharged at the righthand side of the housing 4, through an axial outlet 6.

In order to ensure an essentially isothermal compression of the gas, generally air, water is injected into the interior of the compressor. This water serves not only for cooling of the gas, but also for lubrication of the contact faces of the rotors 1 and 3.

In the compressor known from US Patent Specification 3,535,057, this water is injected only at the outlet side of the rotors. In the compressor according to the invention water is injected at different, and at several, places.

According to the invention, an injection point is located at point A. This injection point A is directed towards the contact face of the rotors 1 and 3.

Viewed in the lengthwise direction of the compressor, point A lies at a place where the pressure is equal to $2 \sqrt[3]{P}$ plus or minus 0.5 bar, P being equal to the absolute final pressure at the compressor outlet.

Water is also injected at points B and C.

Viewed in the lengthwise direction of the compressor, the two points B lie at a place where the pressure is equal to $\sqrt[3]{P}$ plus or minus 0.5 bar.

The two points C lie at a place where the

pressure is equal to the inlet pressure.

It can be seen from the drawings that the two points B and the two points C always lie on either side of the plane in which point A is situated. Points B and C are also preferably slanted outwards.

Apart from the place of the injection points, in particular the quantity of injected water and the temperature thereof are of essential importance for the invention.

The injected quantity of water per unit time must lie between 1% and 2% of the capacity of the compressor. As regards the distribution of the quantity of water per injection point, according to the invention approximately 50% of the total quantity of water must be injected in point A, approximately 20% in each point B, and approximately 5% in each point C.

The temperature of the injected water is also of essential importance and must be at least 5 K lower than the temperature of the gas sucked in.

The example taken is a compressor with an absolute pressure of 7 bar and a speed of 6,475 rpm.

With oil injection the power at the shaft 2 is 8.33 kw/m³/min.

With injection of water in the same compressor in a quantity of 1% - 2% of the compressor capacity and at a temperature which is at least 5 K lower than the temperature of the gas sucked in, the shaft power is 7.38 kW/m³/min.

In a compressor with the proposed distribution of the injection points, the shaft power is 6.03 kW/m³/min.

By comparison with the oil compressor, a saving of approx. 27% is thus achieved.

Claims

1.Screw compressor with two parallel screws engaging with each other, one of which is driven while the other is carried, surrounded by a stator housing and provided with an inlet for the gas to be compressed and an outlet for the compressed gas, said stator housing also having at least one injection point through which water is injected into the stator housing, **characterized in that** said injection point is located at a place in the stator housing where the pressure is equal to $2 \sqrt[3]{P}$ plus or minus 0.5 bar, and in that further injection points are provided at a place in the stator housing where the pressure is equal to $\sqrt[3]{P}$ plus or minus 0.5 bar and at the inlet side of the gas, P being equal to the absolute final pressure of the compressor.

2.Screw compressor according to Claim 1, **characterized in that** the first-mentioned injection point is directed towards the contact face between

the two screws and the remaining injection points are arranged in two groups of two and slant outwards.

3.Method of driving a screw compressor with two parallel screws engaging with each other, one of which is driven while the other is carried, surrounded by a stator housing and provided with an inlet for the gas to be compressed and an outlet for the compressed gas, said stator housing also having at least one injection point through which water is injected into the stator housing, **characterized in that** the quantity of water injected per unit time is 1% - 2% of the capacity of the compressor, and the temperature of the injected water is at least 5 K lower than the temperature of the gas at the inlet of the compressor.

4.Method according to Claim 3, **characterized in that** the quantity of water injected in the first-mentioned injection point is approximately 50% of the total quantity of injected water, in each of the set of injection points located at $\sqrt[3]{P}$ plus or minus 0.5 bar it is approximately 20%, and in each of the set of injection points located at the inlet side approximately 5%.

fig-1

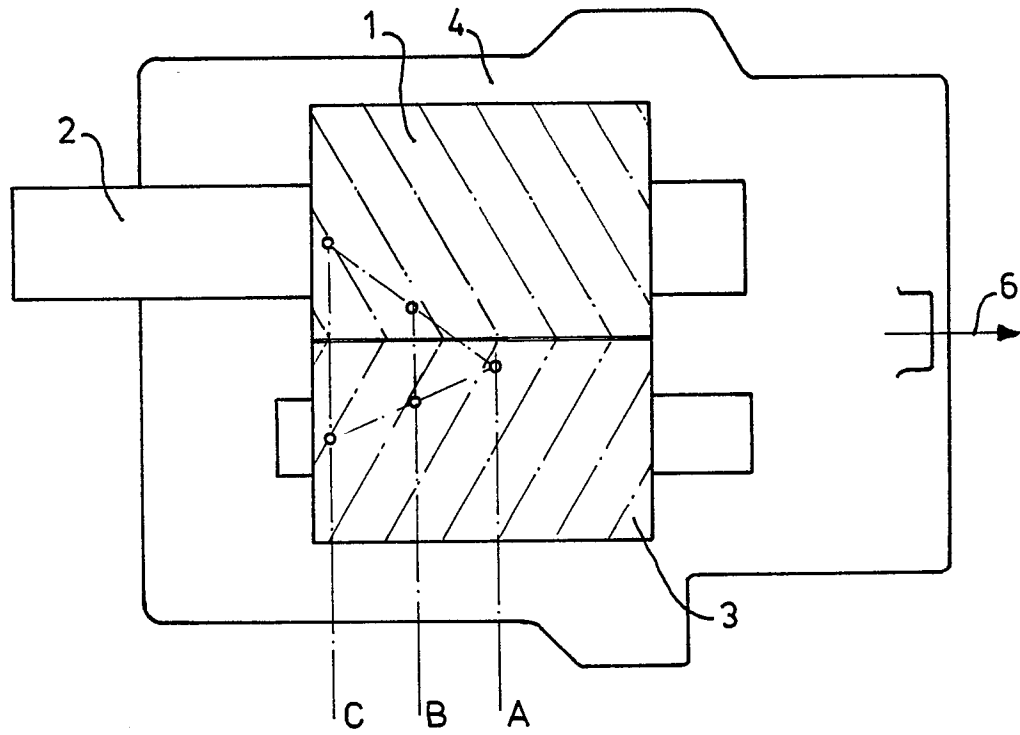
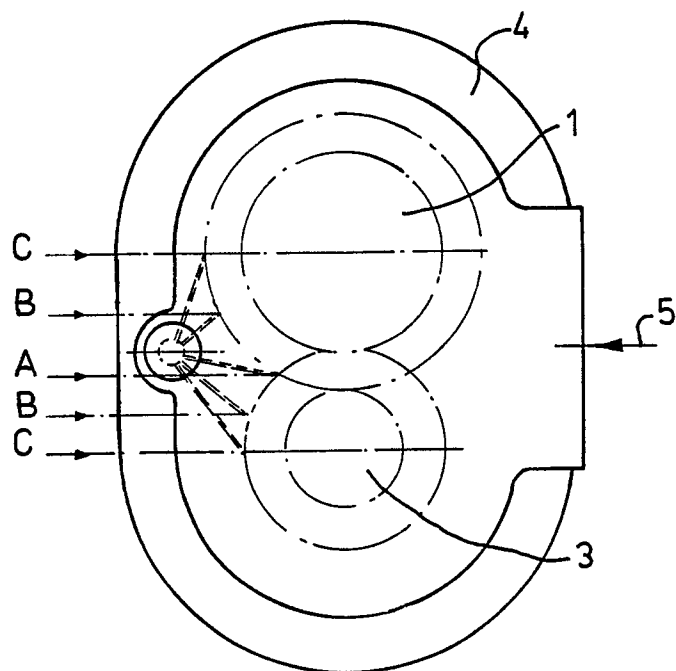


fig-2





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	DE-A-2801408 (LINDE) * page 5, lines 11 - 17 * * page 6, line 23 - page 7, line 5 * * pages 11 - 12; figures 1, 2 * * page 15, lines 15 - 24 * ---	1	F04C29/00 F04C18/16
A	FR-A-2603666 (ZIMMERN) * page 2, lines 1 - 7 * * page 3, lines 1 - 23; figures 1, 2 * ---	1	
A	GB-A-1413426 (ZIMMERN) * page 1, lines 37 - 45 * * page 3, lines 14 - 27 * ---	1, 3	
A	DE-A-2853264 (WERNER RIETSCHLE MASCHINEN-UND APPARATEBAU) * page 3, line 11 - page 4, line 13 * ---	1	
A,D	US-A-3535057 (KODRA) * column 6, lines 27 - 38 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F04C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 20 JUNE 1990	Examiner KAPOULAS T.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	