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(54) ROTARY PISTON COMPRESSOR

(57) The invention is concerned with the field of constructing compressors and can be used in stationary and vehicle gas (air) and refrigerating plants, air-conditioners, and heat pumps. In a rotary piston compressor comprising an epitrochoidal casing with a rotor situated on an eccentric shaft, a lubricant-containing crankcase is fastened to a rear side cover. A system of channels is embodied as an inclined or radial opening formed within an expansion zone and as an axial opening connected thereto through a large-diameter chamber and passing through the casing and connected to the ejector. Radial channels are formed in the working surfaces of the side covers in order to connect the crankcase cavity to the working chambers during a suction period via an annular gap formed between the eccentric shaft and the rear side cover. A device for metering the supply of lubricant is embodied as a spring-loaded valve and a flexible split ring that has a gap of a predetermined metering size at the location of the slit. The valve is mounted in front of the ejector in the large-diameter chamber. The split flexible ring is mounted in the annular gap between the eccentric shaft and the rear side cover, wherein said annular gap is covered by the ring, and a gap of a predetermined metering size is formed at the location of a slit of said ring.

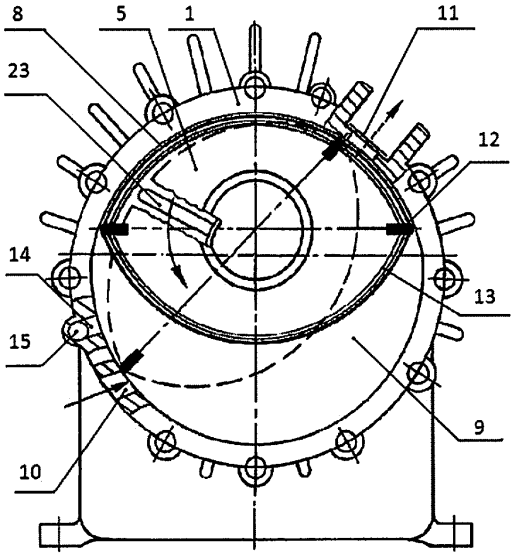

Fig. 2

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Description

[0001] The invention is concerned with the field of constructing compressors and can be used in stationary and vehicle gas (air) and refrigerating plants, air-conditioners, and heat pumps.

[0002] Advantages of rotary piston compressors over piston ones consist in absence of reciprocation members, which allows good specific mass and size per unit, reduction in vibration and noise level.

[0003] Known is a rotary piston compressor comprising an epitrochoidal casing with a front and a rear side cover and with a rotor arranged within a cavity of said casing and situated on an eccentric shaft, wherein the casing, the side covers and the rotor form variable-volume working chambers, a system for lubricating working surfaces of the compressor, the system comprising a lubricant-containing oil tank, a lubricant sprayer embodied as an ejector a nozzle of which is communicated by a pipe to said oil tank, and a system of channels made in the eccentric shaft and connecting the ejector to the working chambers (the USSR Inventor's Certificate No. 315,800 published on October 1, 1971, Bull. No. 29).

[0004] The specificity of rotary piston compressors consists in that, for want of space to locate effective end-face seals of the rotor and on account of complicated oil removal from the compressor, the simplest and safest method for preventing the surplus of oil from entering the working chambers is metering the supply of oil.

[0005] Said prior art rotary piston compressor has disadvantages as follows.

1. Metering an amount of oil to be supplied is absent.
2. As the ejector is connected to the working chambers and to the oil tank all the time, an excessive, unmonitored amount of oil is entrained through the oil tank during suction; because of said specificity of rotary piston compressors, said amount of oil is mainly blown out into atmosphere in gas (air) rotary piston compressors thereby to: deteriorate ecology; increase oil leakages out of the system; and result in intensified carbonization, especially in a pressure valve.
3. The oil tank is additionally required, said tank being no part of the compressor structure and being arranged outside of it similar to an ejector with oil pipes. At low environmental temperatures that can be as low as down to minus 55 °C under operation conditions, the oil gets viscous such that the ejector (yes, rather other type of the pump as well) cannot draw it in from the oil tank and supply to a user.
4. The ejector operates only at presence of a certain pressure drop, while said drop can be (significantly) lower, for example, during sand blasting, painting and other works when the ejector does not operate.
5. The ejector is made of pipes having a small outer diameter of the order of 8 to 10 mm; since said pipes are out of the compressor, they can be easily damaged (broken) in transportation and operation of the compressor.
6. Location of the ejector in front of a front end of the shaft excludes (or strongly complicates) the possibility to mount a pressure fan impeller thereto.

[0006] Also known is a rotary piston compressor comprising an epitrochoidal casing with a front and a rear side cover and with a rotor arranged within a cavity of said casing and situated on an eccentric shaft, wherein the casing, the side covers and the rotor form variable-volume working chambers, a system for lubricating working surfaces of the compressor, the system having a lubricant-containing crankcase, a lubricant sprayer embodied as an ejector a nozzle of which is communicated by a pipe with a bottom part of the crankcase, and a system of channels connecting the ejector to the working chambers, and a device for metering the supply of lubricant into an axial bore of the eccentric shaft (the USSR Inventor's Certificate No. 1,231,263 published on May 15, 1986, Bull. No. 18; prototype).

[0007] This compressor partially eliminates the first one of the disadvantages listed above, exactly, a metering unit embodied as a vane-type shutter with a drive provided with a time relay is mounted at an inlet to a radial bore of the eccentric shaft, which allows reduction in an amount of a gas-oil mixture supplied into the shaft during an expansion period.

[0008] However, this metering unit complicates the structure and reduces the compressor operation reliability.

[0009] Further, said compressor has other disadvantages listed above.

[0010] The invention is based on an object to develop a rotary piston compressor where the cost-effective supply of a lubricant to friction surfaces of the compressor is provided due to modification of an ejector location and switching of lubrication system channels as well as introduction of novel structural members.

[0011] Said object is accomplished in that, in a rotary piston compressor comprising an epitrochoidal casing with a front and a rear side cover and with a rotor which is arranged in a cavity of said casing and is situated on an eccentric shaft, wherein the casing, side covers and rotor form variable-volume working chambers, a system for lubricating working surfaces of the compressor, the system having a lubricant-containing crankcase, a lubricant sprayer embodied as an ejector a nozzle of which is communicated by a pipe to the bottom part of the crankcase, a system of channels connecting the ejector to the working chambers, and a device for metering the supply of lubricant, according to the invention, the system of channels is embodied as a radial or inclined opening formed within an expansion zone in the casing and as an opening connected thereto via a large-diameter chamber and passing in an axial direction through the casing, a flange of the rear side cover and a front flange of the crankcase and connected to the ejector, and radial chan-

nels are formed in the working surfaces of the side covers in order to connect the crankcase cavity to the working chambers during a suction period via an annular gap formed between the eccentric shaft and the rear side cover, while the device for metering the supply of lubricant is embodied as a spring-loaded valve and a split flexible ring that is preferably made of an anti-friction material and has a gap of a predetermined metering size at the location of its slit, of which valve and ring the spring-loaded valve is mounted in front of the ejector in said large-diameter chamber, and the split flexible ring is mounted in the annular gap between the eccentric shaft and the rear side cover, wherein said annular gap is covered by the ring, and a gap of a predetermined metering size is formed at the location of the slit of said ring.

[0012] A cushion volume is formed above the spring-loaded valve.

[0013] The slit ring can be mounted in both an annular groove formed in an opening of the rear side cover, and in an annular groove formed in a body of the eccentric shaft.

[0014] Said object is also accomplished in that, that, in a rotary piston compressor comprising an epitrochoidal casing with a front and a rear side cover and with a rotor which is arranged in a cavity of said casing and is situated on an eccentric shaft, wherein the casing, side covers and rotor form variable-volume working chambers, a system for lubricating working surfaces of the compressor, the system having a lubricant-containing crankcase, a lubricant sprayer embodied as an ejector a nozzle of which is communicated by a pipe to the bottom part of the crankcase, a system of channels connecting the ejector to the working chambers, and a device for metering the supply of lubricant, according to the invention, an additional lubricant-spraying means is mounted in the crankcase and is embodied as a driving gear and a driven gear meshed with each other, wherein the driving gear is rigidly fastened on the eccentric shaft while a shaft of the driven gear is fixedly fastened in a lower part of the rear side cover such that a part of said gear is arranged lower than a lower mark of a lubricant level.

[0015] An embodiment of the compressor in accordance with the instant invention provides advantages as follows.

[0016] The compressor of the invention provides more accurate metering an amount of oil supplied to friction parts of the working chambers.

[0017] A necessary and unmonitored amount of oil is entrained during suction. Therefore, the blowout of oil into the atmosphere is limited to minimum, and carbonization is decreased. The need of the oil tank not exists any longer because the compressor structure includes the crankcase. Oil is heated from the rear side cover of the compressor at low environmental temperatures. Notwithstanding that the ejector operates at presence of a certain pressure drop, while said drop can be (significantly) lower, for example, during sand blasting, painting and other works when the ejector does not operate., however, the lubrication system operates even so, because an additional, backup system sprays oil, said system consisting of two meshed rotating gears the lower of which is a driven one and is continuously within an oil bath of the crankcase.

[0018] Since the ejector is placed into the crankcase, the possibility of damaging pipes thereof during transportation and operation of the compressor is excluded.

[0019] The invention is explained by drawings, wherein:

Fig. 1 is a longitudinal sectional view of a compressor;

Fig. 2 is a transverse view of the compressor with a front cover removed;

Fig. 3 and Fig. 4 are fragments of a lubrication system;

Fig. 5 and Fig. 6 are variants of the arrangement of metering rings.

[0020] A rotary piston compressor (hereinafter referred to as the compressor) consists of an epitrochoidal casing 1 covered at end faces by front and rear side covers 2, 3, and an eccentric shaft 4 having a rotor 6 mounted on an eccentric portion of said shaft. A crankcase 6 is fastened to an end face of the rear side cover 3 and closed by a crankcase cover 7 at a rear end face. A lower part of the crankcase is filled with oil (Fig. 1); a breather is absent in the crankcase.

[0021] The epitrochoidal casing 1, the side covers 2, 3 and the rotor 5 form variable-volume working chambers 8 and 9. Fig. 2 shows the rotor 5 in two positions: by a solid line when a volume of the chamber 8 is minimal (harmful) and a volume the chamber 9 is maximal (total); and by a dashed line in an intermediate position when an inlet port 10 begins to open.

[0022] A pressure valve 11 is mounted in an outlet (pressure) well of the casing 1. Radial and end-face seal strips 12 and 13 are mounted in the rotor 5, said strips being tighten against the working surfaces by expanders and providing the hermetic sealing of the working chambers 8 and 9.

[0023] A lubrication system (Fig. 2, 3 and 4) of the compressor is embodied as an inclined or radial opening 14 formed in a working surface of the epitrochoidal casing 1 within an expansion process zone and as an axial opening 15 connected thereto and passing through the epitrochoidal casing 1, a flange of the rear side cover 3 and a front flange of the crankcase 6 to which the ejector is coaxially coupled, said ejector consisting of a nozzle 16 and a pipe 17 (Figs. 1, 3, 4), wherein a cylindrical chamber 18 is formed in the epitrochoidal casing, is connected coaxially with or perpendicularly to the radial opening 14 or the axial opening 15 and has a diameter larger than that of the approaching openings 14 and 15, said chamber being closed at an end face by the front side cover 2 (Fig. 3) in radial arrangement of said chamber and by a plug 19 (Fig. 4) in axial arrangement thereof. A self-

operated valve 20 embodied as a piston (Fig. 3, 4) or a ball (not shown in the drawings) is mounted within the cylindrical chamber 18. An additional cushion volume 21 is attached to the cylindrical chamber 18, while a spring 22 is mounted above the piston (ball); radial channels 23 (Fig. 2) are formed in the operating surfaces of the side covers 2 and 3, said channels connecting a cavity of the crankcase 6 to the working chambers 8 and 9 via an annular gap between the eccentric shaft 4 and the rear side cover 3 during the suction process.

[0024] Location of the ejector within the crankcase 6 near the rear side cover 3 improves operation conditions thereof at low temperatures, because the cover 3 is heated when the compressor operates, so oil in the vicinity of said cover is heated as well and the viscosity of oil decreases. The ejector is protected against damage within the crankcase.

[0025] Annular grooves to fit split rings 24 (Fig. 5) or 25 (Fig. 6) made preferably of an anti-friction material are formed at the location of the eccentric shaft 4 within the opening of the rear side cover 3 in said cover or in the eccentric shaft, said rings being pressed to the eccentric shaft 4 (Fig. 5) or to the opening of the rear side cover 3 (Fig. 6) by an intrinsic elasticity force and have a gap of a predetermined metering size at the location of a slit, said gap metering an amount of a gas-oil mixture supplied to friction parts of the working chambers for lubrication.

[0026] Within the crankcase, the compressor further comprises a driving gear 26 rigidly fastened on the eccentric shaft 4 and a driven gear 27 (Fig. 1) continuously meshed therewith and mounted on a shaft 28, said driven gear being fixedly fastened in a lug of the lower part of the rear side cover 3 such that the lower part of the driven gear is continuously arranged within oil irrespective of its level. Said gear pair is an additional backup lubricant-spraying means.

[0027] The compressor operates as follows. The eccentric shaft 4 is driven into rotation from a motor shaft (conditionally not shown). The rotation is transmitted from the eccentric shaft to the rotor 5 which moves planetary while rotating with the motor shaft and being turned relative to it. When the rotor rotates, a volume of the working chambers 8 and 9 is cyclically varied from minimal one to maximal one due to which the working process takes place. In Figs. 1 and 2, the rotor 5 is shown by solid lines in an initial position when an injection process ends in the working chamber 8 and a suction process takes place in the working chamber 9. In Fig. 2, the rotor 5 is shown by dashed lines in an intermediate position when an expansion process ends (or is close to end) in the operation chamber 8, and a radial strip 12 begins to open an inlet port 10 thereby to begin the suction process. Gas is sucked through the inlet port 10. A compression process takes place in the working chamber 9; upon achievement of an injection pressure, the pressure valve 11 is open and the compressed gas is expelled out of said chamber. Upon return of the rotor 5 to the initial position, the working chambers 8 and 9 swap over, and the cycle is further repeated.

[0028] The compressor is lubricated by a gas-oil mixture. When the radial seal strip 12 passes by the radial opening 14 (Figs. 3, 4), a pressurized gas is expelled out of said opening, presses the spring 22 out and, as shown in Figs. 3 and 4, moves the piston (ball) 20 to the leftmost position (Fig. 3) or the uppermost position (Fig. 4) to open a passage for a gas flow into the axial opening 15 and the injector nozzle 16 and to rarefy its cross-section of the smaller area due to which oil is drawn in from the crankcase 6 and is ejected by the nozzle 16 into the crankcase as a fine-dispersed gas-oil mixture that fills the crankcase. Since the working chambers 8 and 9 communicate with the crankcase through the annular gap between the rear side cover 3 and the eccentric shaft 4 and also through the radial channels 23, the gas-oil mixture is sucked into said chambers when the suction process takes place therein. To meter an amount of the gal-oil mixture supplied for lubrication, the annular gap has flexible split rings 24 or 25 fitted in the read side cover (Fig. 5) or in the eccentric shaft 4 (Fig. 6) and having a gap of a predetermined (metering) size. But the ejector nozzle 16 also communicates with the working chambers 8 and 9 during the suction process, wherein the gas-oil mixture can be drawn in through said nozzle. To lock or limit the supply of said mixture to an amount necessary for lubrication of the working surface of the epitrochoidal casing 1, the pistons (balls) 20 are mounted that fit into their seats when subjected to the rarefaction in the working chambers of the epitrochoidal casing 1 and when subjected to the force of the spring 22, thereby to close the passage for drawing the gas-oil mixture in completely or partially. Thus, it is possible to avoid the increased oil flow rate, the carbonization, the blowout to the atmosphere, and to improve ecology. This is also promoted by absence of the breather. The additional cushion volume 21 reduces the effect of pump strokes and makes the movement of the piston (ball) 20 easier.

[0029] To provide reliable, trouble-free operation of the compressor, the backup lubrication system is also used. At a higher viscosity of oil and during operation of the compressor under reduced power conditions when the gas pressure in the expansion process is insufficient and the ejector cannot operate, oil in the crankcase 6 will be pulverized by the driven gear 27 immersed therein and driven by the driving gear 26.

Claims

1. A rotary piston compressor comprising an epitrochoidal casing with a front and a rear side cover and with a rotor which is arranged in a cavity of said casing and is situated on an eccentric shaft, wherein the casing, side covers and rotor form variable-volume working chambers, a system for lubricating working surfaces of the compressor, the system having a lubricant-containing crankcase, a lubricant sprayer

embodied as an ejector a nozzle of which is communicated by a pipe to the bottom part of the crankcase, a system of channels connecting the ejector to the working chambers, and a device for metering the supply of lubricant, said compressor being **characterized in that** the crankcase is fastened to the rear side cover in order to contain the lubricant, the ejector is mounted within the crankcase, and the system of channels is embodied as an inclined or radial opening formed within an expansion zone and as an axial opening connected thereto through a large-diameter chamber and passing through the casing, a flange of the rear side cover and a front flange of the crankcase and connected to the ejector, and radial channels are formed in the working surfaces of the side covers in order to connect the crankcase cavity to the working chambers during a suction period via an annular gap formed between the eccentric shaft and the rear side cover, while the device for metering the supply of lubricant is embodied as a spring-loaded valve and a split flexible ring that is preferably made of an anti-friction material and has a gap of a predetermined metering size at the location of its slit, of which valve and ring the spring-loaded valve is mounted in front of the ejector in said large-diameter chamber, and the slit flexible ring is mounted in the annular gap between the eccentric shaft and the rear side cover, wherein said annular gap is covered by the ring, and a gap of a predetermined metering size is formed at the location of the slit of said ring.

2. The rotary piston compressor according to claim 1, **characterized in that** a cushion volume is formed above the spring-loaded valve.

3. The rotary piston compressor according to claim 1, **characterized in that** the slit ring is mounted in an annular groove formed in an opening of the rear side cover.

4. The rotary piston compressor according to claim 1, **characterized in that** the slit ring is mounted in an annular groove formed in a body of the eccentric shaft.

5. A rotary piston compressor comprising an epitrochoidal casing with a front and a rear side cover and with a rotor which is arranged in a cavity of said casing and is situated on an eccentric shaft, wherein the casing, side covers and rotor form variable-volume working chambers, a system for lubricating working surfaces of the compressor, the system having a lubricant-containing crankcase, a lubricant sprayer being embodied as an ejector a nozzle of which is communicated by a pipe to the bottom part of the crankcase, a system of channels connecting the ejector to the working chambers, and a device for metering the supply of lubricant, said compressor being **characterized in that** an additional backup lubricant-spraying means is mounted in the crankcase and is embodied as a driving gear and a driven gear meshed with each other, wherein the driving gear is rigidly fastened on the eccentric shaft while a shaft of the driven gear is fixedly fastened in the lower part of the rear side cover such that a part of said gear is arranged lower than a low mark of a lubricant level.

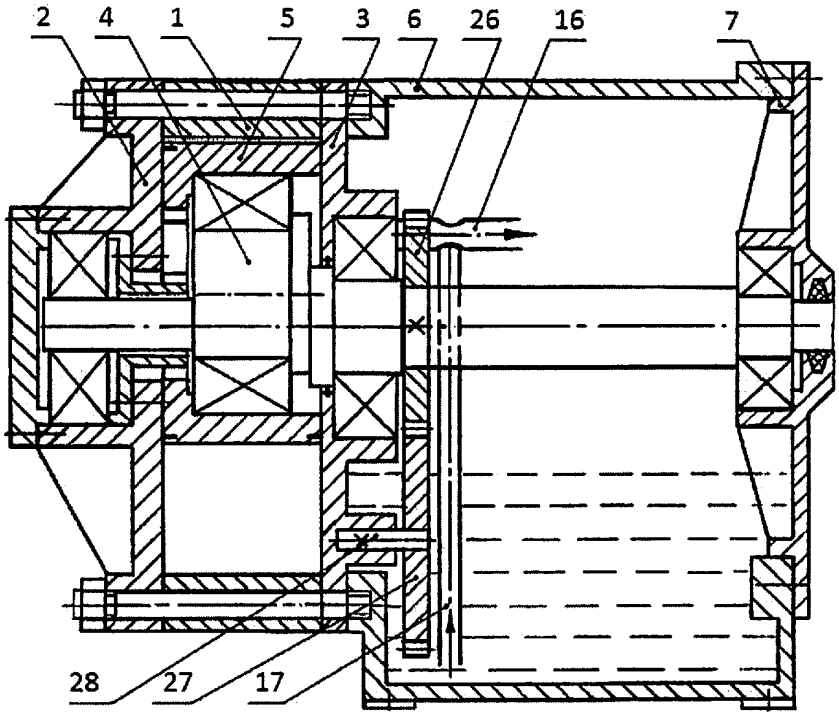

Fig. 1

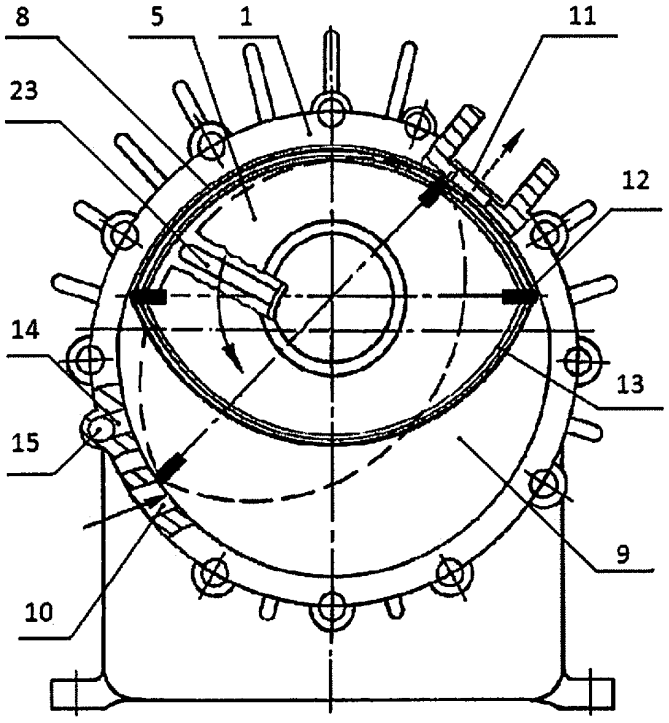

Fig. 2

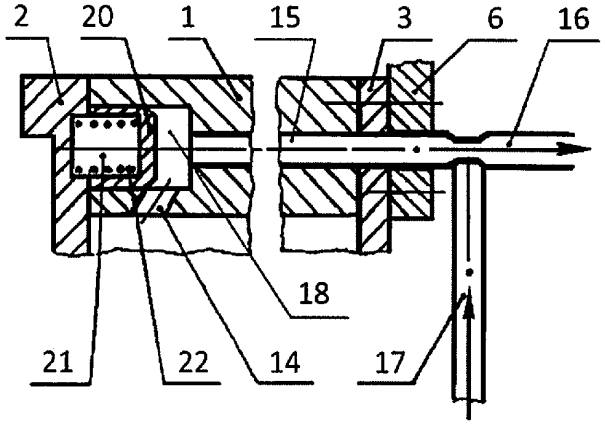

Fig. 3

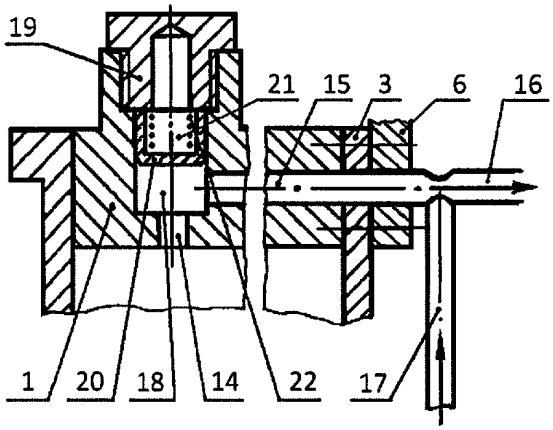

Fig. 4

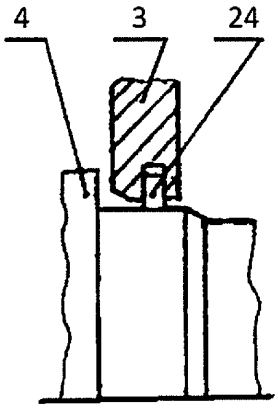

Fig. 5

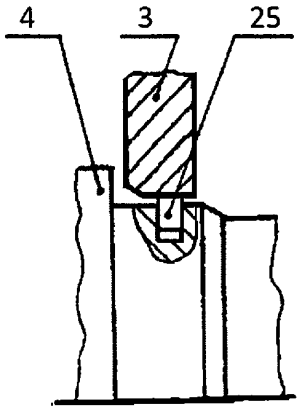

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/UA 2011/000059

A. CLASSIFICATION OF SUBJECT MATTER

F04C 29/02 (2006.01) F04C 18/22 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DEPATISNET, DWPI, EAPATIS, ESP@CENET, JPO, PAJ, PatFT, PatSearch, RUPAT, RUABRU, RUPAT-OLD, RUABU1, RUPATABRU, RUPM, RUPMAB, USPTO, WIPO, **Fond Rosssiiskoi patentnoi dokumentatsii**

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	SU 1231263 A 1 (KHARKOVSKII AVIATSIONNYI INSTITUT IM. N. E. ZHUKOVSKOGO) 15.05.1986, the claims, fig.	5
Y	JP 2004092710 A (HONDA MOTOR CO LTD) 25.03.2004, The abstract, fig.1	5
Y	RU 21301 U 1 (ROMANOV FEDOR FEDOROVICH et. al.) 10.01.2002, p. 3, lines 15- 17, fig. 3	5
A	DE 3322069 A1 (ARMATEC FTS-ARMATUREN GMBH & CO KG) 20.12.1984	1-5
A	SU 1160112 A (KHMELNITSKII ZAVOD TRAKTOROV AGREGATOV) 07.06.1985	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 November 2011 (17.11.2011)	24 November 2011 (24.11.2011)
Name and mailing address of the ISA/ Facsimile No.	Authorized officer Telephone No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 1231263 A **[0006]**