(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 054 155 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
22.11.2000 Bulletin 2000/47

(21) Application number: **99910888.9**

(22) Date of filing: **20.01.1999**

(51) Int. Cl.[7]: **F04B 19/06**

(86) International application number:
PCT/RU99/00017

(87) International publication number:
WO 00/34654 (15.06.2000 Gazette 2000/24)

(84) Designated Contracting States:
DE GB

(30) Priority: **08.12.1998 RU 98122022**

(71) Applicants:
- **Eliseev, Vyacheslav Nikolaevich**
  Orenburg, 460006 (RU)
- **Sazonov, Jury Appolonievich**
  Orenburg, 460047 (RU)
- **Judin, Igor Stanislavovich**
  Moscow, 121858 (RU)
- **Petrov, Alexandr Mikhailovich**
  Orenburg, 460006 (RU)

(72) Inventors:
- **Eliseev, Vyacheslav Nikolaevich**
  Orenburg, 460006 (RU)
- **Sazonov, Jury Appolonievich**
  Orenburg, 460047 (RU)
- **Judin, Igor Stanislavovich**
  Moscow, 121858 (RU)
- **Petrov, Alexandr Mikhailovich**
  Orenburg, 460006 (RU)

(74) Representative:
Barlow, Roy James et al
J.A. KEMP & CO.
14, South Square
Gray's Inn
London WC1R 5LX (GB)

(54) METHOD FOR PUMPING GAS-LIQUID MIXTURES AND PISTON PUMP

(57) Novelty in the invention is that during the intake stroke and the gas compression stroke a gas-liquid mixture is fed into the working chamber through a hydraulic channel from a zone at the outlet of the discharge valve of the working chamber. The hydraulic channel is made in a cut-off element of the discharge valve and is formed by means of a separator, filter, choke with adjustable hydraulic resistance and a bush with axial and radial holes.

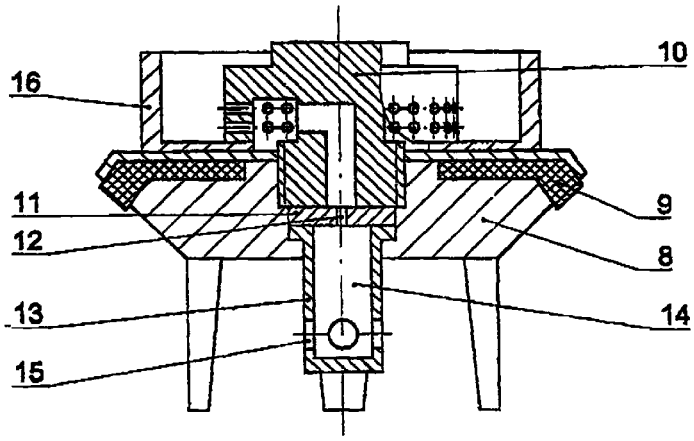

Fig .2

EP 1 054 155 A1

Description

[0001] The invention relates to methods for pumping gas and a gas-liquid mixture with a piston pump, in particular, for drilling, completing a well and producing oil.

[0002] Methods are widely known for pumping a gas-liquid mixture with a piston pump comprising a working chamber with intake and discharge valves, wherein gas or a gas-liquid mixture with a predetermined overpressure is introduced directly into the working chamber of the piston pump. Such a method is disclosed, for example, in USSR Inventor's Certificate No. 714044 (F 04 B 23/10, published 5 February 1980), and makes it possible to efficiently solve the problem of pumping gas-liquid mixtures. At the same time, it should be noted that for a number of technological installations, for example, on offshore oil platforms, very strict requirements are stipulated with respect to the weight and size of pumps and compressors. In that case, the tendency during design of the equipment is to reduce the volumes of the working chambers and to decrease the length of inlet and outlet pipelines.

[0003] The object of the present invention is to expand the functional possibilities of a pump, adapt the construction of a piston pump to pumping gas (a gas-liquid mixture).

[0004] The technical result which may be attained when the claimed method is carried out is enhancement of the efficiency of pumping gas (a gas-liquid mixture) by accelerating the separation process in the working chamber of the pump.

[0005] The technical result which may be attained when the claimed piston pump is realized is enhancement of reliability, reduction of the specific quantity of metal used, reduction of the size.

[0006] Attainment of the stated object with achievement of the aforesaid technical result is fulfilled in a method for pumping gas-liquid mixtures with a piston pump comprising working chambers with intake and discharge valves, by feeding a gas-liquid mixture into at least one working chamber under excess pressure during the period when the pump is carrying out the intake stroke, ensuring the supply of liquid into that working chamber, wherein during the intake stroke and the gas compression stroke, the supply of the gas-liquid mixture is additionally carried out into the working chamber through a hydraulic channel from a zone at the outlet of the discharge valve of the working chamber. In the gas-liquid mixture fed into the working chamber through the hydraulic channel, an increased volumetric content of the liquid in the mixture is provided during the intake stroke with a subsequent reduction of the volumetric content of the liquid during the gas compression stroke in the working chamber, wherein adjustment of the flow of the gas-liquid mixture and its density is carried out in the hydraulic channel by partial separation of the gas.

[0007] This method may be carried out with a device of a novel construction, in particular, a pump with valve distribution, which has the following substantial distinctions.

[0008] A working chamber via a hydraulic channel is constantly in communication with a zone at the outlet of a discharge valve. The hydraulic channel is made in a cut-off element of the discharge valve and is formed by means of a separator, filter, choke and bush with axial and radial holes, which are mounted in the cut-off element.

[0009] The essence of the invention is explained by Figs. 1 and 2, where a diagram of the device for carrying out the method for pumping gas-liquid mixtures with a piston pump is shown.

[0010] The device shown in Fig. 1 includes a piston pump comprising a working chamber 1, filled with a gas-liquid mixture, a piston 2, an intake valve 3 and a discharge valve consisting of a cut-off element 4 and a seat 5. A hydraulic channel 6, connecting a zone 7 above the cut-off element 4 to the working chamber 1, is made in the cut-off element 4.

[0011] The cut-off element of the discharge valve is shown in Fig. 2. The cut-off element includes a body 8, a sealing element 9. A bore is made in the body 8 in which bore a filter 10, a choke 11 with a hole 12, a bush 13 with an axial hole 14 and radial holes 15, are disposed. The filter 10 is disposed inside a separator 16. Adjustment of the hydraulic resistance is achieved by changing the flow section of the hole 12 in the choke 11.

[0012] The device operates in the following manner.

[0013] When the pump is carrying out the intake stroke, see Fig. 1, the gas-liquid mixture from a source (not shown in the drawings) is supplied via the intake valve 3 into the working chamber 1 of the pump, the piston 2 in accordance with the diagram moves to the right. At the same time from the zone 7 at the outlet of the discharging valve a gas-liquid mixture with an increased content of liquid is fed via the hydraulic channel 6 into the working chamber 1. The concentration of the liquid in the mixture at this moment is higher due to the operation of the separator mounted on the cut-off element 4 closing the seat 5. The absence of circulation in the gap between the seat 5 and the cut-off element 4 results in degassing of the gas-liquid mixture which is above the cut-off element 4, gas with a lower density rises, and the liquid with a higher density is accumulated in the cavity of the separator due to the force of gravitation. Thus, during the intake stroke, a gas-liquid mixture with a higher volumetric content of the liquid fraction, i.e. a mixture with higher density, flows through the channel 6.

[0014] When the pump is effecting the gas compression stroke, and the piston 2 is moving to the left in accordance with the diagram in Fig. 1, the gas-liquid mixture will continue to enter the working chamber 1 via the hydraulic channel 6. The supply of gas in the makeup of the gas-liquid mixture from the zone 7 into the working chamber 1 promotes an increase of the pressure in the chamber 1, a forcing downward of the

interface between the liquid phase and the gas phase. Wherein, the process of passing gas bubbles through the liquid layer in the working chamber 1, between the intake valve 3 and the interface between the liquid phase and the gas phase, is accelerated. During the ejection stroke, when the pressure in the chamber 1 becomes equal to the pressure in the zone 7, the cut-off element 4 rises above the seat 5 as a result of the forceful action of the gas-liquid mixture. The discharge valve goes to the open state. At first, gas which has been accumulated under the discharge valve, leaves the chamber 1. Then the gas-liquid mixture is forced out through the gap between the cut-off element 4 and the seat 5, since complete separation of the mixture is difficult to achieve during a short working cycle. At the end of the discharge stroke, liquid or a gas-liquid mixture with a high volumetric content of the liquid is forced out of the working chamber 1. Such a mixture, with a higher density, fills the volume of the separator 16, see Fig. 2. The ejection stroke is completed, the piston 2 is in the far left position in accordance with the diagram. The discharge valve closes, the working cycle is repeated.

[0015] The volume of the separator 16 during the intake stroke is filled with a gas-liquid mixture having a higher volumetric content of the liquid phase, this meaning with a higher density. Thus, during the intake stroke it becomes possible to reduce the volumetric flow of gas flowing through the choke 11 back into the working chamber. This means that the filling of the working chamber with the gas-liquid mixture entering through the intake valve is increased. By adjusting the flow section of the hole 12 in the choke 11, it is possible to achieve optimum efficiency of the pump when pumping the gas-liquid mixture, which is confirmed by experimental research. The area of the cross section of the hole 12 may be changed, for example, by replacing the part 11 with another part of different size. The hole 14 and the radial holes 15 make it possible to direct the flow of the gas-liquid mixture against the solid walls of the working chamber of the pump, thus enhancing the separation conditions, increasing the efficiency of the pump. The filter 10 protects the choke 11 against mechanical impurities and promotes an increase of the reliability of the pump as a whole.

[0016] When the pump is used for pumping gas, liquid is simultaneously fed together with the gas through the intake valve 3 in order to forcefully form the gas-liquid mixture, wherein the whole process coincides with the process described above.

Claims

1. A method for pumping gas-liquid mixtures with a piston pump comprising working chambers with intake and discharge valves, by feeding a gas-liquid mixture into at least one working chamber during the period when the pump is carrying out an intake stroke, ensuring the supply of liquid into that working chamber, **characterized in that** during the intake stroke and a gas compression stroke the gas-liquid mixture is additionally fed into the working chamber through a hydraulic channel from a zone at the outlet of the discharge valve of the working chamber.

2. A method according to claim 1, **characterized in that** in the gas-liquid mixture fed into the working chamber through the hydraulic channel, an increased volumetric content of the liquid is provided during the intake stroke with a subsequent reduction of the volumetric content of the liquid in the mixture during the gas compression stroke in the working chamber.

3. A method according to claims 1, 2, **characterized in that** adjustment of the flow of the gas-liquid mixture and its density is carried out in the hydraulic channel by partial separation of the gas.

4. A piston pump for carrying out the method according to claim 1, comprising a working chamber with an intake valve and a discharge valve, a piston, a source of a gas-liquid mixture (or sources of gas and liquid), **characterized in that** it is additionally provided with a hydraulic channel, constantly coupling the working chamber with a zone at the outlet of the discharge valve.

5. A piston pump according to claim 4, **characterized in that** the hydraulic channel is made in a cut-off element of the discharge valve and is formed by means of a separator, filter, choke with an adjustable hydraulic resistance and bush with axial and radial holes, which are mounted in the cut-off element.

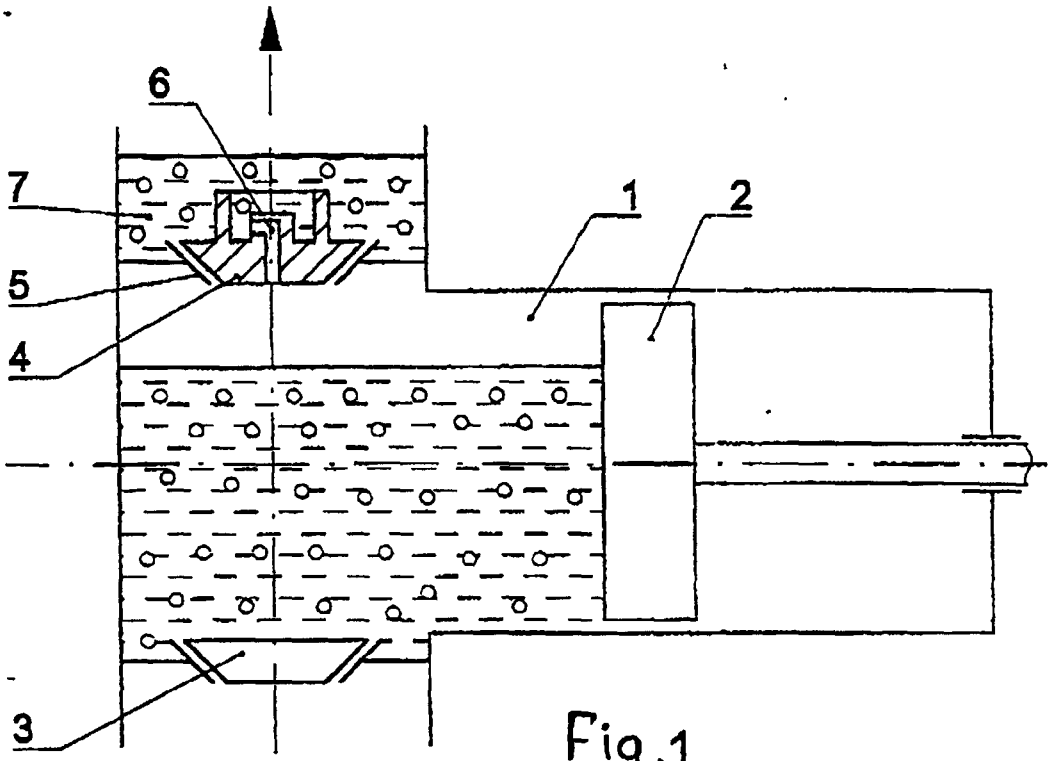

Fig.1

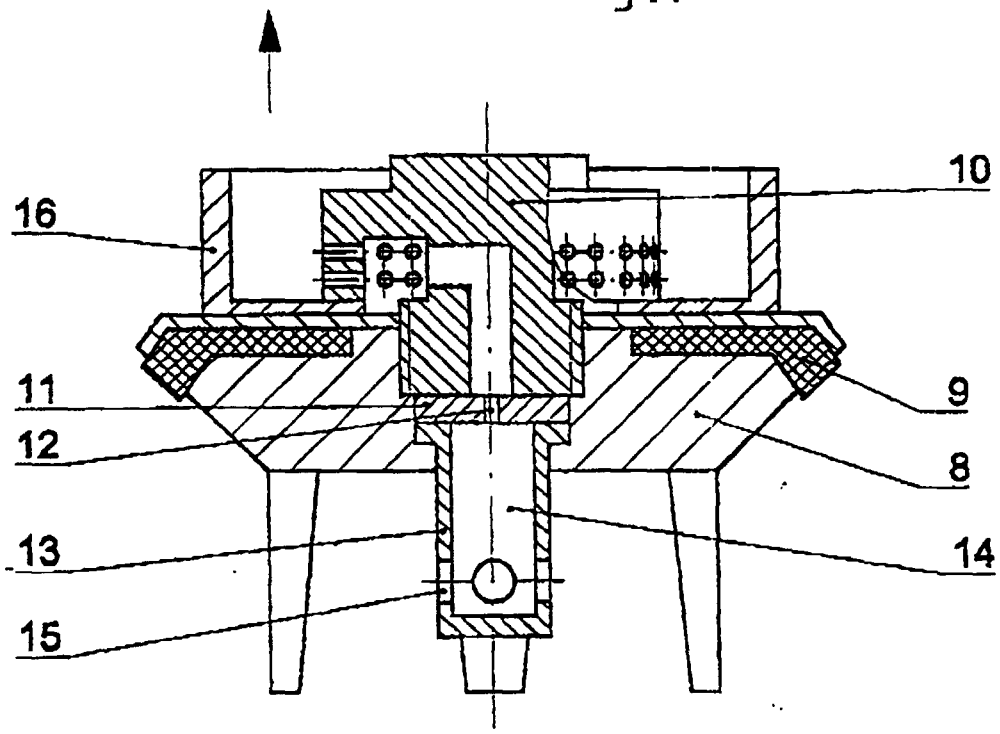

Fig .2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 99/00017

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 : F04B 19/06
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)
IPC 7 : F04B, 19/00, 19/06, 23/00 – 23/10

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 practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SU 714044 A (VSESOJUZNY NAUCHNO-ISSLEDOVATELSKY INSTITUT BUROVOI TEKHNIKI) 05 February 1980 (05.02.80)	1-5
A	SU 1758285 A1 (VSESOJUZNY NAUCHNO-ISSLEDOVATELSKY INSTITUT BUROVOI TEKHNIKI) 30 August 1992 (30.08.92)	1-5
A	SU 1435810 A1 (VSESOJUZNY NAUCHNO-ISSLEDOVATELSKY INSTITUT BUROVOI TEKHNIKI) 07 November 1988 (07.11.88)	1-5
A	US 3929399 A (COMPUMP SYSTEMS, INC) 30 December 1975 (30.12.75)	1-5
A	FR 2235295 A (VSESOJUZNY NAUCHNO-ISSLEDOVATELSKY I PROEKTNO-KONSTRUKTORSKY INSTITUT NEFTYANOGO MASHINO-STROENIA « VNIINEFTEMASH ») 24 January 1975 (24.01.75)	1-5

☐ Further documents are listed in the continuation of box C. ☐ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot beconsidered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 August 1999 (27.08.99)	02 September 1999 (02.09.99)
Name and mailing address of the ISA/ RU	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)