

(19)



(11)

**EP 2 161 450 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**10.03.2010 Bulletin 2010/10**

(51) Int Cl.:  
**F04B 23/10** (2006.01) **F04B 47/04** (2006.01)  
**F04F 7/02** (2006.01)

(21) Application number: **09478002.0**

(22) Date of filing: **02.09.2009**

(84) Designated Contracting States:  
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR**  
Designated Extension States:  
**AL BA RS**

(72) Inventors:  
• **Ciciskinas, Leontijus**  
**10150 Vilnius (LT)**  
• **Bloze, Vladas**  
**09117 Vilnius (LT)**

(30) Priority: **03.09.2008 LT 2008066**

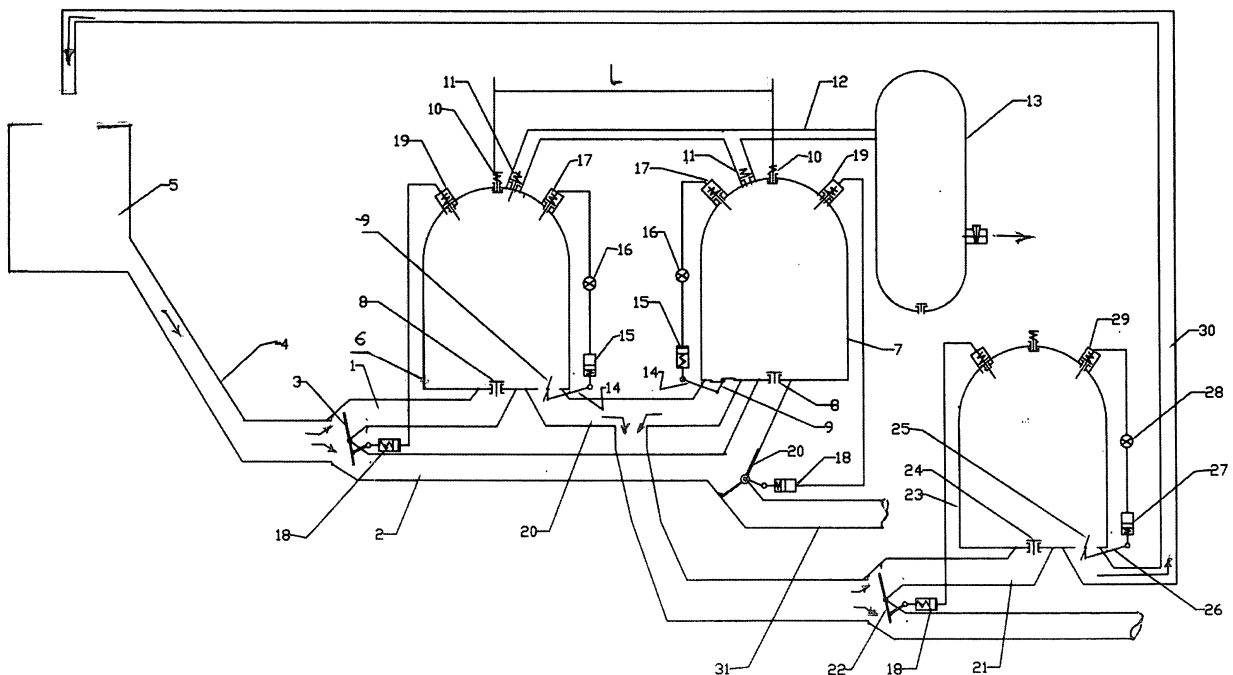
(74) Representative: **Guobys, Vytautas**  
**Vytautas Guobys Patent Agency**  
**Ateities g. 3-9**  
**LT-08306 Vilnius (LT)**

(71) Applicant: **UAB "Alnora"**  
**09117 Vilnius (LT)**

(54) **Water hammer driven air compressor**

(57) The present invention is designed for air compressors driven by a periodically induced water hammer. With the aim to expand the range of application of said water hammer driven air compressor and maximize utilization of kinetic water energy by converting it into pressurized air energy, said compressor has two water intake

pipes (1) and (2) with impact valves (3) connected to water reservoir (5) and two air reservoirs (6) and (7) with water intake (8) and outlet (9) valves and air intake valves (10) connected to an air intake pipe (12). The water outlet valves (9) are controlled by the air pressure in the reservoirs (6) and (7).



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## Description

**[0001]** The present invention is designed for air compressors driven by a periodically induced water hammer. A water hammer is frequently used in hydraulic rams, water lifting equipments applied to supply water when water supply exceeds water demand and the lifting equipment may be installed below the source of water. Although the efficiency of a hydraulic ram is only from 0.2 to 0.4, its major advantage is an ability to use free water energy.

**[0002]** SU 1652674 describes a water hammer driven air compressor having a water feeder with an integrated impact valve and a reservoir divided by a resilient diaphragm into an air and a water compartment. The air compartment has a reverse air intake valve and is hosed via a reversal valve to a pressurized air supply pipe. The water compartment is connected with a water supply pipe.

**[0003]** The aforementioned air compressor converts kinetic energy of a water flow into pressurized air energy and allows a more efficient use of potential and kinetic water energy since its operation is based on the use of additional kinetic energy of water obtained in a place of a water level alteration. A deficiency of the compressor is insufficient use of water's kinetic energy as only a portion of the constant water flow in the water supply pipe is used to generate energy of pressurized air. The remaining part of the water flow is simply flushed down.

**[0004]** RU 2239102, which discloses the closest prior art, describes a water hammer driven air compressor used in hydraulic ram. The compressor has two water supply pipes with integrated impact valves connected by a swinging lever and two air reservoirs with water intake valves. One air reservoir is connected via a water outlet valve and a pressurized pipe to a water transfusion compartment. The other reservoir has a water outlet valve connected via a swinging lever and an air supply pipe to the water transfusion compartment. Pressurized air in the first air reservoir drives water into the water transfusion compartment while air in the other reservoir drives water from the water transfusion compartment to a pressurized water reservoir.

**[0005]** The major deficiency of this compressor is that it is designed only to lift water and cannot be used as an independent source of pressurized air which can be applied for various purposes. Besides, it is difficult to adjust its optimal operational mode as it is impossible to control air pressure level and duration. Water supply is used inefficiently - it is simply let out into surrounding environment.

**[0006]** The objective of the invention is to expand the range of application of the water hammer driven air compressor and maximize utilization of kinetic water energy by converting it into pressurized air energy with minimal waste of water.

**[0007]** According to the present invention there is provided a water hammer driven air compressor having two

water intake pipes with impact valves connected to a water reservoir and two air reservoirs with water intake and outlet valves one of which is connected to an air intake pipe, the air reservoirs have air intake valves, the water outlet valves of its reservoirs and are controlled by the air pressure in the air reservoirs and the second air reservoir is connected to an air supply pipe which may be coupled with an air receiver.

**[0008]** The water outlet valves in the air reservoirs are connected via a unit of levers, a pneumatic cylinder and a pneumatic throttle with an air pressure valve.

**[0009]** The air reservoirs are connected via water outlet valves to an outlet pipe which can be connected to a hydraulic ram feeding the used water back to the water reservoir. The hydraulic ram has a water supply pipe with an impact valve, an air reservoir with a water intake valve and a water outlet valve connected via a unit of levers, a pneumatic cylinder and a pneumatic throttle with an air pressure valve and a pressure pipe connected to the water reservoir.

**[0010]** The described water hammer driven compressor with or without hydraulic ram may comprise only the first level of a compressor unit. One of the water supply pipes of the first and each following level is connected to a following level of the compressor.

**[0011]** The layout of the invention is given in the attached drawing.

**[0012]** The water hammer driven air compressor comprises water supply pipes 1 and 2 with a swinging impact valve 3 connected to a supply pipe 4 coupled with a water reservoir 5 and air reservoirs 6 and 7 with water intake 8 and outlet 9 valves and air intake valves 10. The air reservoirs 6 and 7 are connected via air pressure valves 11 and an air supply pipe 12 to an air receiver 13. The water outlet valves 9 are connected via a unit of levers 14, a pneumatic cylinder 15 and a pneumatic throttle 16 to an air pressure valve 17. The impact valve 3 is connected via a pneumatic cylinder 18 to an air pressure valve 19. A drain 20 is installed below the water outlet pipes 9. The air reservoirs 6 and 7 are arranged to each other at the distance "L" which is fixed depending on the speed of the water flow in supply pipes 1 and 2.

**[0013]** The water hammer driven compressor may be assembled with a hydraulic ram connected to the drain 20. The hydraulic ram has a water supply pipe 21 with a swinging impact valve 22 connected to the drain 20, an air reservoir 23 with a water intake valve 24 and a water outlet valve 25 connected via a unit of levers 26, a pneumatic cylinder 27 and a pneumatic throttle 28 with an air pressure valve 30 and a pressure pipe connected to the water reservoir 5.

**[0014]** The described water hammer driven compressor may be used as the first level of a compressor unit. In this case, the pipe 31 makes a supply pipe for the following level (absent in the drawing) of the compressor unit.

**[0015]** Water hammer driven air compressor operates as follows.

[0016] On an immediate turn of the impact valve 3 opened by the spring of the pneumatic cylinder 18, water from the water reservoir 5 flows via the feeding pipe 4 and the supply pipe 1 towards the C. The pressurized water flow in the supply pipe 1 opens the water intake valve 8 and fills a part of reservoir 6 and enhances air pressure in it. The pressurized air via the pressure valve 17, the pneumatic throttle 16, the pneumatic cylinder 15 and the unit of levers 14 immediately turns the impact valve 3 and closes the water flow to the supply pipe 1 thus inducing a water hammer in it. The air compressed by water in the reservoir 6 is driven via the pressure valve 11 and through the air supply pipe 12 to the air receiver 13 connected to a number of recipients. At the same time, the compressed air passes via the pressure valve 17, the pneumatic throttle 16 with a controlled delay into the pneumatic cylinder 15 which via the unit of levers 15 opens the water outlet valve 9 and the water from the reservoir 6 passes to the drain 20. The air passes via the intake valve 10 into the air reservoir 6 and sets it for a subsequent cycle.

[0017] As the impact valve 3 keeps the supply pipe 1 closed, the water from the feeding pipe 4 flows through the supply pipe 2 towards the air reservoir 7 until the flow rate achieves the value at which the impact valve 3 immediately turns and closes the pipe 2 inducing a water hammer in it. As the pressure increases, the water opens the water intake valve 8 of the reservoir 7 and fills a part of the reservoir 7. The air compressed by water in the reservoir 7 is driven via the pressure valve 11 and through the air supply pipe 12 to the air receiver 13. At the same time the compressed air from the reservoir 7 passes with a controlled delay via the pressure valve 17, the throttle 16 to the pneumatic cylinder 15 which via the unit of levers 15 opens the water outlet valve 9 and the water from the reservoir 7 flows into the drain 20.

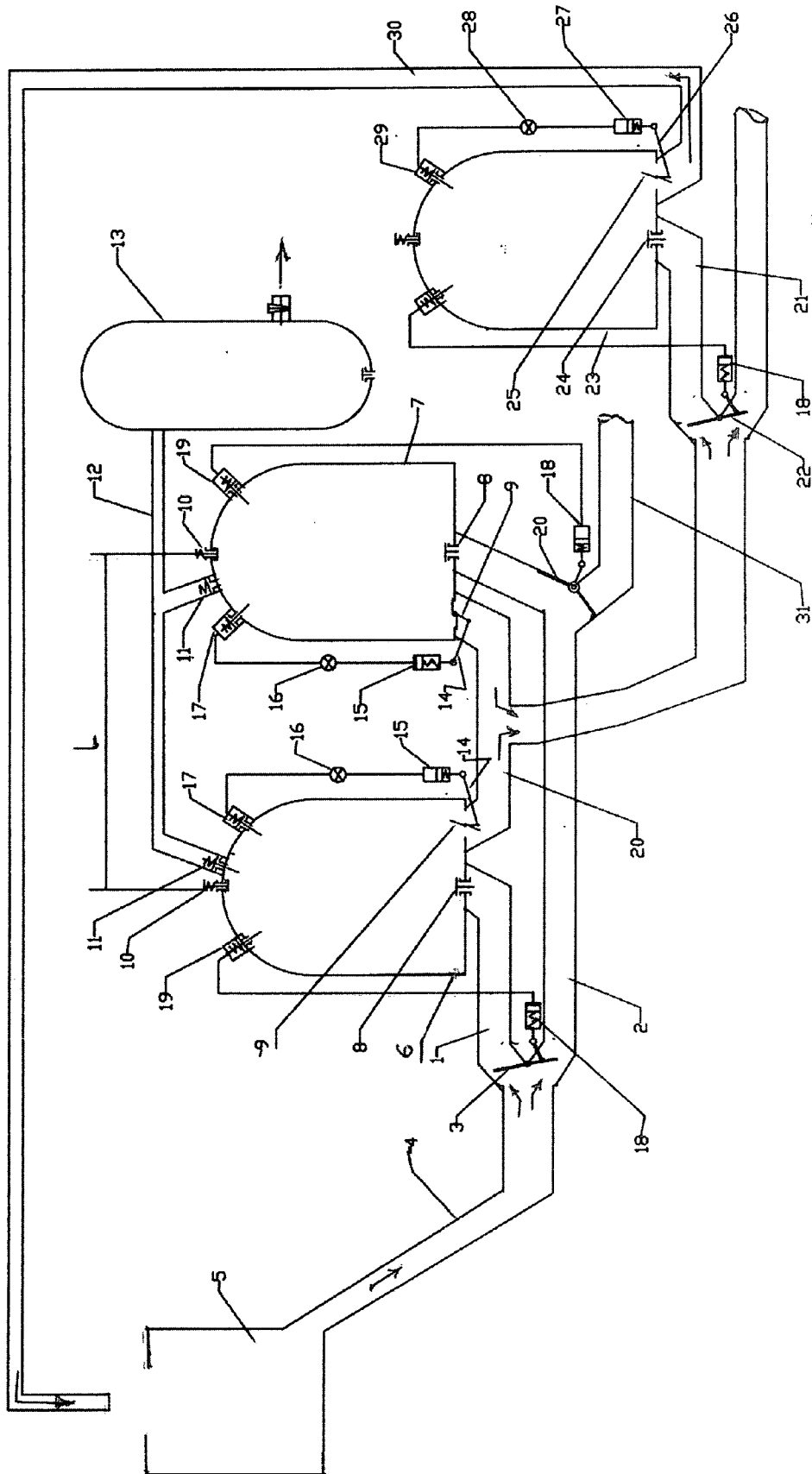
[0018] If the drain 20 is coupled with a hydraulic ram, on an immediate turn of the impact valve 22 opened by the spring of the pneumatic cylinder 18 of the air reservoir 23, water from the drain 20 functioning now as a feeding pipe flows via the supply pipe 21 towards the air reservoir 23. The pressure of the water flow in the feeding pipe 21 opens the intake valve 24 and the water fills a part of the reservoir 23 and advances air pressure in it which via the pressure valve 29, the pneumatic throttle 28, the pneumatic cylinder 27 and the unit of levers 26 immediately turns the impact valve 22 and closes water flow into the feeding pipe 21 inducing at the same time a water hammer in it. The compressed air passes via the pressure valve 29, the pneumatic throttle 28 into the pneumatic cylinder 27 which via the unit of levers 26 opens the water outlet valve 26 and the water from the reservoir 23 passes to the drain 20 and flows back to the reservoir 5.

### Claims

1. A water hammer driven air compressor having two

water intake pipes (1) and (2) with impact valves (3) connected to a water reservoir (5) and two air reservoirs (6) and (7) with water intake (8) and outlet (9) valves wherein one air reservoir (7) is connected to an air intake pipe (12), **characterized in that** said air reservoirs (6) and (7) have air intake valves (10), said water intake (8) and outlet (9) valves of said reservoirs (6) and (7) are controlled by the air pressure in the said reservoirs (6) and (7) and **in that** the second air reservoir (6) is connected to said air supply pipe (12).

2. A compressor according to claim 1 **characterized in that** said air supply pipe (12) is connected with an air receiver (13).
3. A compressor according to claim 1 and/or 2 **characterized in that** said water outlet valves (9) in said air reservoirs (6) and (7) are connected via a unit of levers (14), a pneumatic cylinder (15) and a pneumatic throttle (16) to an air pressure valve (17).
4. A compressor according to claim 3 **characterized in that** said air reservoirs (6) and (7) are connected via said water outlet valves (9) to a drain pipe (20).
5. A compressor according to claim 4 **characterized in that** said drain pipe (20) is coupled with a hydraulic ram which drives the used water back to said water reservoir (5).
6. A compressor according to claim 5 **characterized in that** said hydraulic ram has a water supply pipe (21) with an impact valve (22), an air reservoir (23) with a water intake valve (24) and a water outlet valve (25) connected via a unit of levers (26), a pneumatic cylinder (27) and a pneumatic throttle (28) with an air pressure valve (29) and a pressure pipe (30) connected to a water reservoir (5).
7. A compressor according to any of claims 1 to 4 or 1 to 5 **characterized in that** it is used as the first level of a compressor unit.
8. A compressor according to claim 7 **characterized in that** one of said water supply pipes of the first and each following level is connected to a following level of the compressor.





EUROPEAN SEARCH REPORT

Application Number  
EP 09 47 8002

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 00/36306 A1 (DAWSON, MARK A. [AU]) 22 June 2000 (2000-06-22) * page 1, line 3 - line 25 * * page 4, line 26 - page 6, line 25 * * figure 1 *	1-8	INV. F04B23/10 F04B47/04 F04F7/02
A	DE 11 2004 002323 T5 (INCOTELOGY LTD. [DE]) 24 May 2007 (2007-05-24) * paragraph [0013] * * figure 1 *	1-8	
A	EP 0 274 374 A2 (STEVEN, PHILIPPE [BE]) 13 July 1988 (1988-07-13) * column 1, line 3 - line 52 * * column 2, line 16 - column 3, line 56 * * figures 1,2 *	1-8	
A	DE 31 49 841 A1 (PFISTER & LANGHANSS [DE]) 30 June 1983 (1983-06-30) * page 4, line 14 - column 5, line 22 * * figure 1 *	1-8	
A	FR 2 444 823 A1 (MAC GREGOR, DANIEL [FR]) 18 July 1980 (1980-07-18) * the whole document *	1-8	
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Place of search		Date of completion of the search	Examiner
Munich		16 December 2009	Gnächtel, Frank
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	

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 47 8002

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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16-12-2009

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**REFERENCES CITED IN THE DESCRIPTION**

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- SU 1652674 [0002]
- RU 2239102 [0004]