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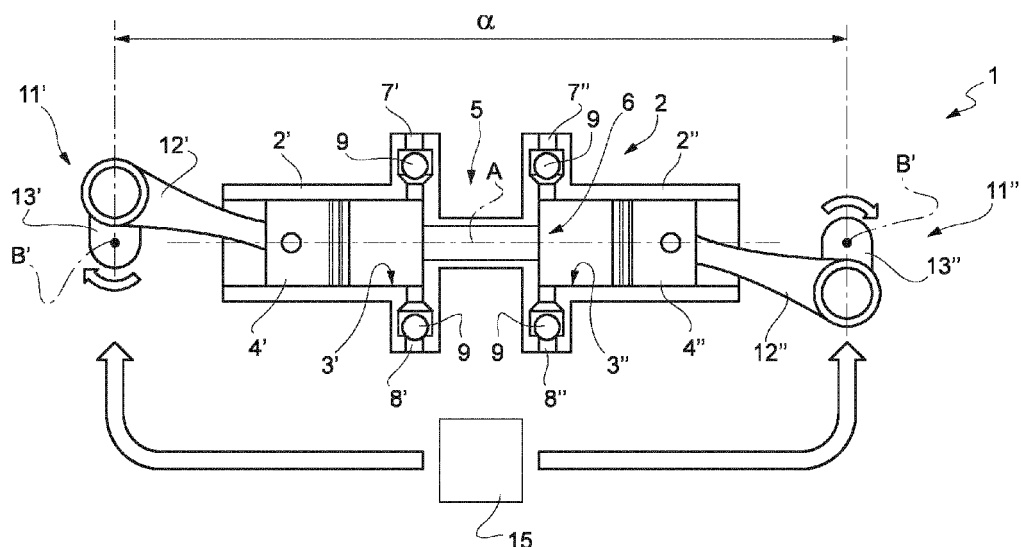
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(54) **PUMP SYSTEM FOR A FIREFIGHTING MIXTURE GENERATION SYSTEM**

(57) Pump system (1) for a firefighting mixture generation system, comprising a housing (2) defining at least a pair of portions (2', 2'') each defining a respective space (3', 3'') and comprising a piston (4', 4'') configured to slide in a fluid tight manner in each of the space (3', 3'') and a crankshaft system (11', 11'') configured to rotate about a respective axis (B', B'') to move pistons (4', 4'') along

a common travel axis (A), wherein spaces (3', 3'') are fluidly connected together to define a delivery volume (6), the pump system (1) comprises regulation means (15) configured to vary the angular phase between the crankshaft systems (11', 11'') of pistons (4', 4'') to vary the delivery volume (6) while crankshaft systems (11', 11'') is maintained constant.

FIG. 1



Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102022000003083 filed on February 18, 2022, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention concerns a pump system, in particular a variable volume pump system for a generation system of a firefighting mixture to be used for firefight.

[0003] The present invention finds its preferred, although not exclusive, application in a generation system of a firefighting mixture; reference will be made to this application by way of example below even if it that may be applied to other purposes.

BACKGROUND OF THE INVENTION

[0004] Firefighting vehicles comprise firefighting mixture generation systems configured to provide a firefighting mixture fluid that can be used by rescuers in firefighting operations.

[0005] Such firefighting mixture generation system comprises pump means configured to pressurize a fluid, such as foam or water, towards a mixing module.

[0006] As known, the flow of pressurized fluid that may be provided by the pump means strictly depends by the volume of the pump and the rotating speed of power module, such as an internal combustion engine or a electric motor, carrying the pump.

[0007] If the power module has a fixed speed, e.g. the maximum speed, the flow cannot be varied.

[0008] Therefore, the need is felt to provide a mechanical actuated valve for pressurizing fluid that is more versatile than existing ones.

[0009] An aim of the present invention is to satisfy the above mentioned needs in a cost-effective and optimized manner.

SUMMARY OF THE INVENTION

[0010] The aforementioned aim is reached by a pump system as claimed in the appended set of claims.

BRIEF DESCRIPTION OF DRAWINGS

[0011] For a better understanding of the present invention, a preferred embodiment is described in the following, by way of a non-limiting example, with reference to the attached drawings wherein:

- Figure 1 is a schematic representation of a pump according to the invention;

- Figure 2 is a diagram showing the piston stroke and the delivery rate of the pump of figure 1 in function of the crankshaft rotation;
- Figure 3 is a schematic representation of a pump according to the invention in a further operational configuration;

- Figure 4 is a diagram showing the piston stroke and the delivery rate of the pump of figure 3 in function of the crankshaft rotation;
- Figure 5 is a schematic representation of a pump according to the invention; and
- Figure 6 is a diagram showing the piston stroke and the delivery rate of the pump of figure 5 in function of the crankshaft rotation.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The attached figures disclose a pump system 1 configured to suck a fluid from a source of fluid, i.e. an upstream source of fluid (not shown), pressurize such sucked fluid and provide the latter to an operative module, i.e. a downstream operative module (not shown) for related use of this latter.

[0013] In particular, the source of fluid may be a tank of fluid, such as foam or water, or an external source such as a hydrant and the operative module may be a mixing system of a firefighting mixture system of a firefighting vehicle.

[0014] The pump system 1 comprises a casing 2 comprising two main portions 2', 2" each defining a space 3', 3". In each space 3', 3" a piston 4', 4" may slide in a fluid tight manner.

[0015] In particular, the two spaces 3', 3" are fluidly connected together by a conduit 5 that allows fluidic communication between spaces 3', 3". Accordingly, the spaces 3', 3" and conduit 5 define a common pump volume 6 representing the volume of fluid that may be pumped by pump system 1.

[0016] Pistons 4', 4" are configured to move linearly along a direction of a travel axis A along the respective space 3', 3" that therefore have a variable volume according to the piston position; accordingly, pump volume 6 varies according to variation of spaces 3', 3".

[0017] Preferably, conduit 5 is realized coaxial to said axis A, i.e. coaxial to pistons 4', 4".

[0018] In particular, each space is furthermore connected by a suction conduit 8', 8" to the fluid source and by a delivery conduit 7', 7" to the operative module.

[0019] In particular, pump system 1 comprises a check valve 9 fluidly interposed within each delivery and suction conduits 7', 7", 8', 8" and configured to respectively allow the passage of fluid from fluid source to spaces 3', 3" via suction conduits 8', 8" and allow ejection of pressurized fluid to operative module from spaces 3', 3" via delivery conduits 7', 7".

[0020] Preferably, housing 2, conduit 5 and at least part of delivery and suction conduits 7', 7", 8', 8" is real-

ized as one piece.

[0021] Each piston 4', 4" is carried by a respective crankshaft mechanism 11', 11" configured to carry the piston 4', 4" to slide within the respective space 3', 3" along axis A.

[0022] Each crankshaft mechanism 11', 11" comprises a crankshaft 13', 13" and a connection rod 12', 12" connected by respective movable connections, such as hinges, to the piston 4', 4" and the crankshaft 13', 13". As per se known, the crankshaft 13', 13" rotates about respective rotation axis B', B" thereby moving via connection rod 12', 12" the piston 4', 4" along axis A.

[0023] As can be seen, the connection rods 12', 12" of the pistons are connected on vertically, i.e. in a direction perpendicular to axis A, on opposite position with respect to crankshaft 13', 13".

[0024] In particular, both the crankshaft 13', 13" rotates in the same rotation direction and the pistons 4', 4" are faced one with respect to another.

[0025] The pump system 1 furthermore comprises regulation means 15 configured to vary the rotation phase angle between crankshafts 13', 13". In particular, regulation means 15 can vary the volume 5, i.e. pump flow, between a minimum and a maximum value, even if the crankshafts 13', 13" speed is maintained constant.

[0026] Such regulation means 15 may be realized in a different way, such as via mechanical regulation means e.g. belt connection with adjustable belt length, adjustable hub length of the crankshaft or by electro-mechanical means such as a drive carried by an electric motor.

[0027] The operation of the embodiment of the invention as described above is the following.

[0028] In all embodiments, the pistons 4', 4" are carried in their motion by respective crankshaft systems 11', 11" thereby moving alternatively along axis A direction. Accordingly, when volume 5 is expanded, fluid enters via suction conduits 8', 8" while when the volume 5 is compressed, fluid is ejected through delivery conduits 8', 8". During the operation of the pump, the check valves 9 avoid passage of fluid in the wrong directions.

[0029] In a first operative condition, shown in figure 1, the crankshaft are shifted of an angle α of 180° so that their motion is totally opposite along axis A.

[0030] Making reference to the graph of figure 2, the continuous line indicates the motion of one cylinder and the discontinued line indicates the motion of the opposite cylinder; it is clear that such motions are opposite. In the same graph the dots-lines line indicates the variation of delivery flow of pump 1 that varies accordingly from a minimum to a maximum value.

[0031] In a second operative condition, shown in figure 5, the crankshaft are not shifted, i.e. shifted of an angle β of 0° so that their motion is concordant along axis A.

[0032] Making reference to the graph of figure 6, the continuous line indicates the motion of one cylinder and the discontinued line indicates the motion of the opposite cylinder; it is clear that such motions are concordant. In

the same graph the dots-lines line indicates the variation of delivery flow of pump 1 that is always zero since no variation of volume 6 can be achieved in such motion.

[0033] In a third operative condition, shown in figure 5, the crankshaft are not shifter, i.e. shifted of 0° so that their motion is concordant along axis A.

[0034] Making reference to the graph of figure 6, the continuous line indicates the motion of one cylinder and the discontinued line indicates the motion of the opposite cylinder; it is clear that such motions are concordant. In the same graph the dots-lines line indicates the variation of delivery flow of pump 1 that is always zero since no variation of volume 6 can be achieved in such motion.

[0035] In a fourth operative condition, shown in figure 3, the crankshaft are shifted of an angle comprised between 0° and 180° , so that their motion is partially concordant one with respect to the other.

[0036] Making reference to the graph of figure 4, the continuous line indicates the motion of one cylinder and the discontinued line indicates the motion of the opposite cylinder; it is clear that such motions are concordant. In the same graph the dots-lines line indicates the variation of delivery flow of pump 1 that varies till a value that is lower with respect to maximum value of condition of figures 1 and 2.

[0037] In view of the above, the invention may furthermore be directed to a method for controlling a pump system 1 as described, comprising the following phases:

- receiving a request of a delivery flow value;
- elaborating the value of delivery volume 6 needed to provide the requested delivery flow value; and
- control the angular phase between the crankshaft systems 11', 11" to vary the delivery volume 6 according to the elaborated value while maintaining the crankshaft systems 11', 11" at a constant speed.

[0038] To execute the aforementioned method, the pump system 1, the regulation means 15 and/or the fire-fighting mixture generation system comprising pump system 1 may comprise a control unit comprising elaboration means configured to execute automatically the aforementioned phases of the control method.

[0039] In view of the foregoing, the advantages of a pump system according to the invention are apparent.

[0040] Thanks to the proposed pump system 1 the volume of delivery flow may be adjusted without varying the crankshaft speed. Therefore, the provided pump may be controlled in a very thin way in every speed range of the crankshaft to provide a requested delivery flow.

[0041] Therefore, a fire-fighting mixture system provided with such pump may be controlled in simpler way and provide a very wide range of delivery flow value.

[0042] Moreover, the presence of only a pair, of more pairs if needed, of pistons, allows to provide a very compact and economic variable volume pump with respect to other pump typologies.

[0043] It is clear that modifications can be made to the

described pump system which do not extend beyond the scope of protection defined by the claims.

[0044] For example, more pairs of pistons may be present instead of a single pair of pistons.

[0045] Furthermore, crankshaft system may comprise a different leverismo between crankshaft and the piston.

[0046] Moreover, check valves may be substituted by other equivalent means and the shape of housing 2 may vary.

Claims

1. Pump system (1) for a firefighting mixture generation system, said pump system (1) comprising a housing (2) defining at least a pair of portions (2', 2'') each defining a respective space (3', 3'') and comprising a piston (4', 4'') configured to slide in a fluid tight manner in each of said space (3', 3'') and a crankshaft system (11', 11'') configured to rotate about a respective axis (B', B'') to move said pistons (4', 4'') along a common travel axis (A), wherein said spaces (3', 3'') being fluidly connected together to define a delivery volume (6), said delivery volume (6) being fluidly connectable to a source of fluid and to an operative module of said firefighting mixture generation system, said pump system (1) comprises regulation means (15) configured to vary the angular phase between said crankshaft systems (11', 11'') of said pistons (4', 4'') to vary said delivery volume (6) while said crankshaft systems (11', 11'') is maintained constant.
2. Pump system according to claim 1, wherein if said angular phase can be controlled between an angle of 180° and an angle of 0° to provide respectively a maximum or a minimum delivery volume (6).
3. Pump system according to claim 1 or 2, wherein said crankshaft system (11', 11'') comprises a crankshaft (13', 13'') and a connection rod (12', 12'') operatively interposed between said piston (4', 4'') and said crankshaft (13', 13'').
4. Pump system according to any of the preceding claims wherein said delivery volume (6) is connectable to said source via at least a suction conduit (8', 8'') for each of said space (3', 3'').
5. Pump system according to any of the preceding claims wherein said delivery volume (6) is connectable to said operative module via at least a delivery conduit (7', 7'') for each of said space (3', 3'').
6. Pump system according to any of the preceding claims wherein said spaces (3', 3'') are fluidly connected by a conduit (5) realized between said portions (2', 2'') of said housing.
7. Pump system according to claim 6, wherein said conduit (5) is concentric to said travel axis (A).
8. Pump system according to any of the preceding claims, wherein said pump system (1) is realized as one piece.
9. Pump system according to claims 4 or 5, further comprising valve means (9) operatively interposed within said delivery or suction conduits (7', 7'', 8', 8'') and configured to regulate the flow passage there between.
10. Pump system according to claim 9, wherein said valve means (9) comprises a check valve.
11. Firefighting mixture generation system comprising a pump system (1) according to any of the preceding claims.
12. Firefighting vehicle provided with a firefighting mixture generation system according to claim 11.
13. Method for controlling a pump system (1) according to claims 1 to 10, comprising the following phases:
 - receiving a request of a delivery flow value;
 - elaborating the value of delivery volume (6) needed to provide the requested delivery flow value; and
 - control the angular phase between the crankshaft systems (11', 11'') to vary the delivery volume (6) according to the elaborated value while maintaining the crankshaft systems (11', 11'') at a constant speed.

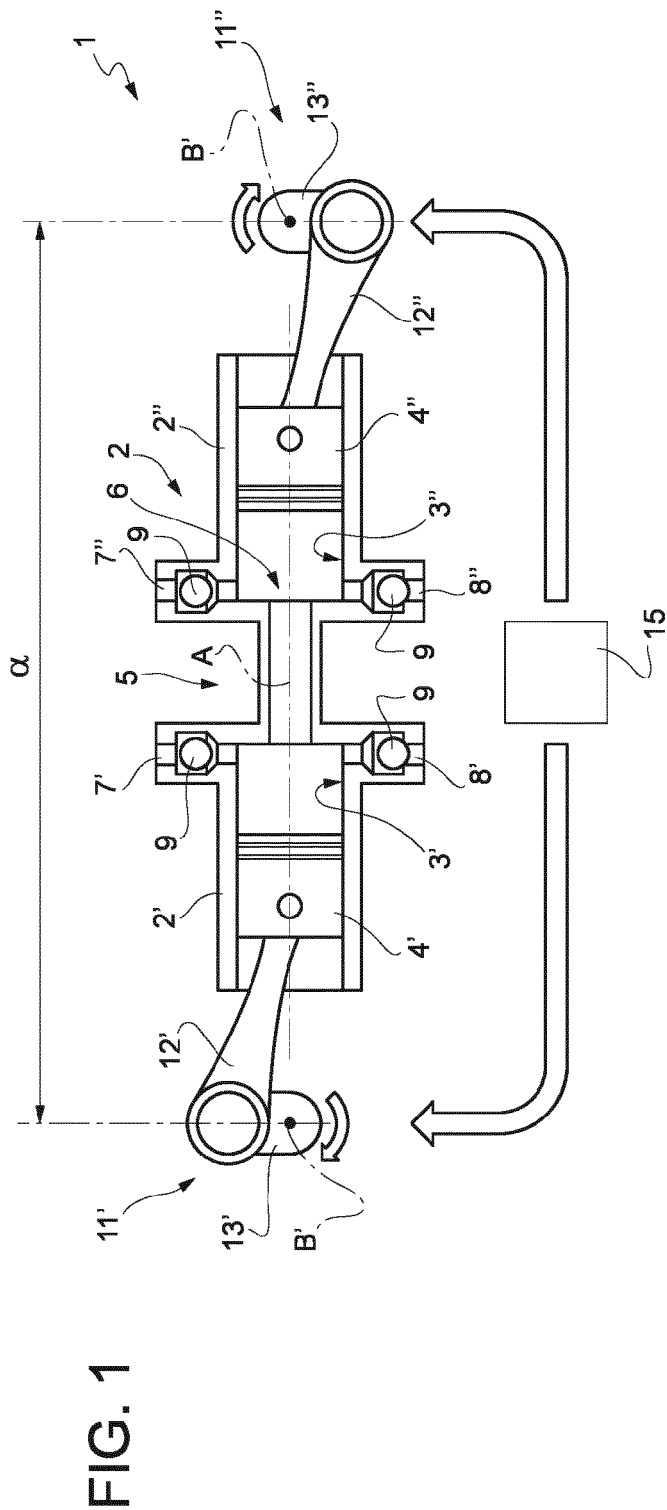
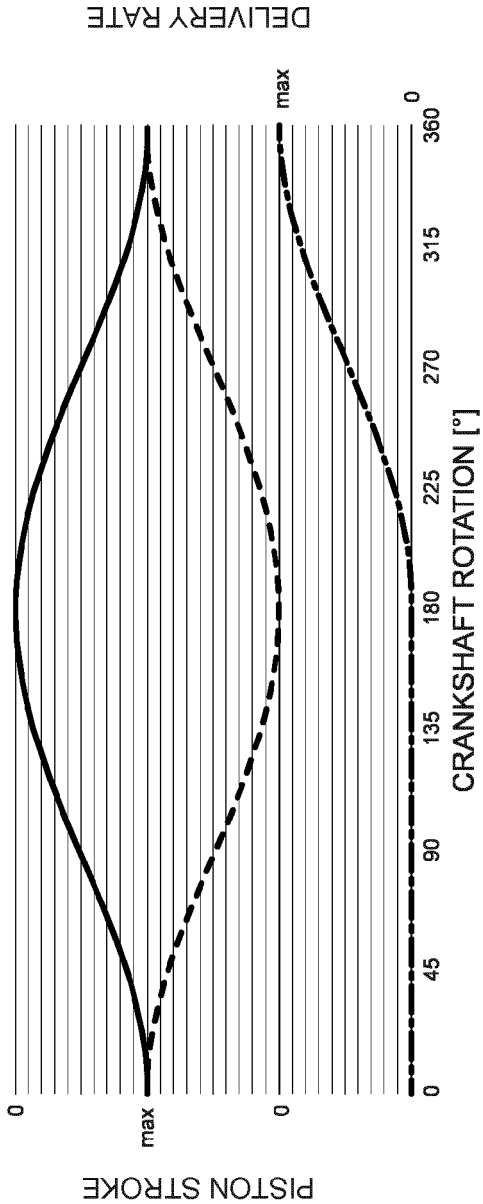


FIG. 2



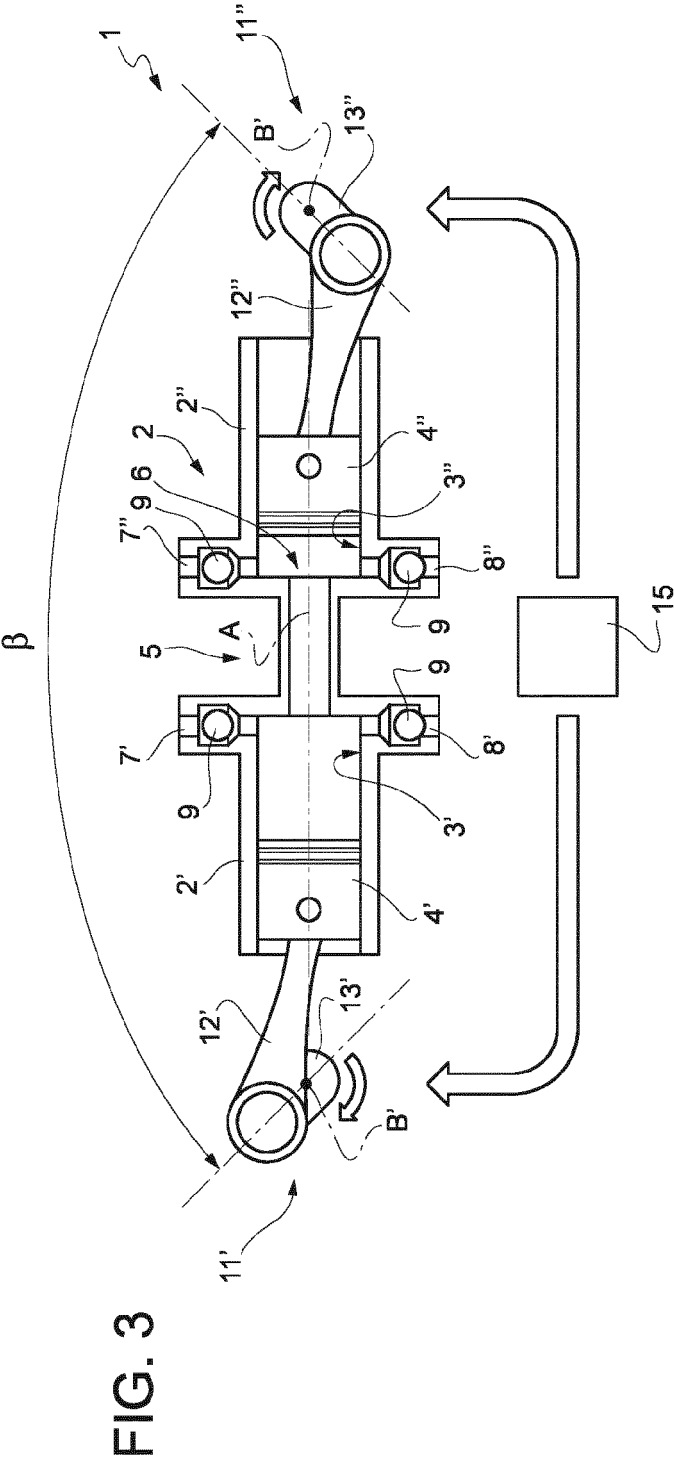
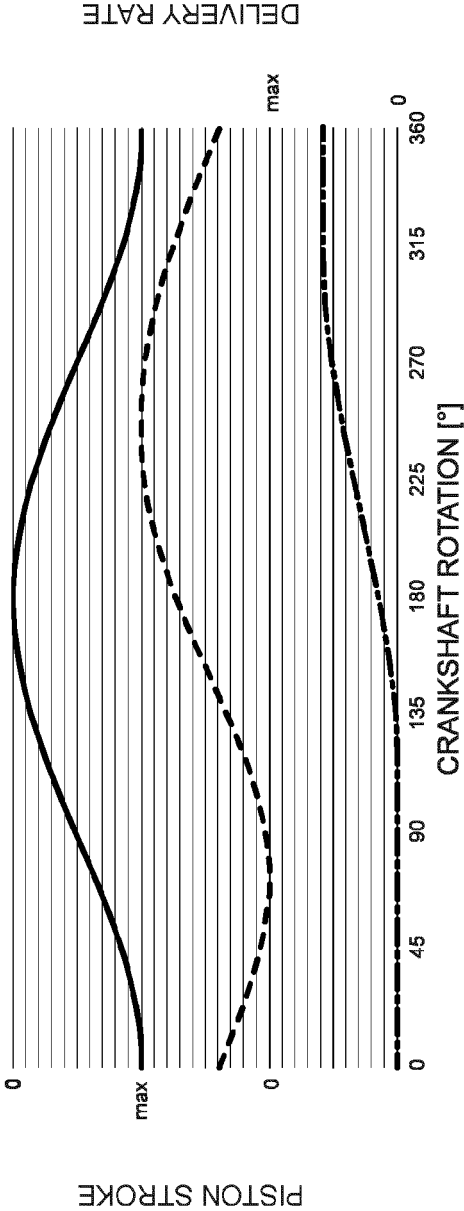


FIG. 4



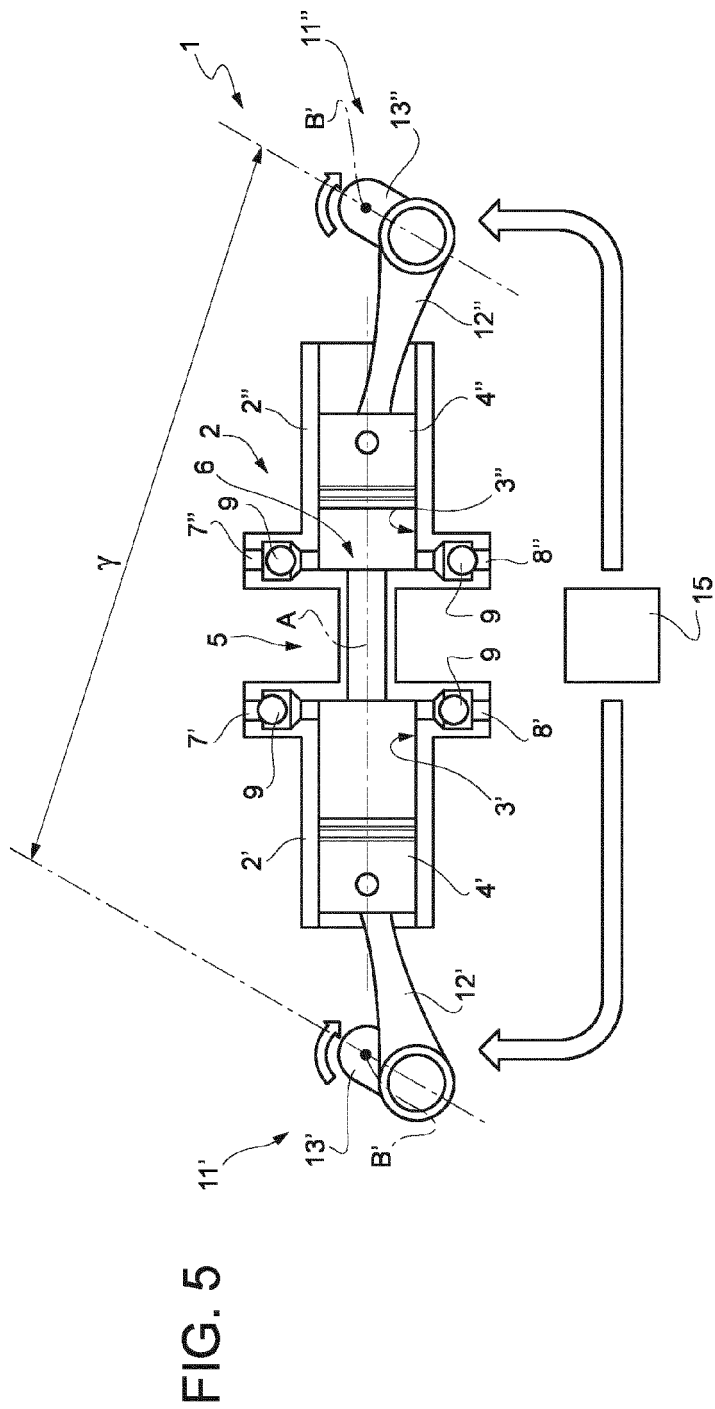
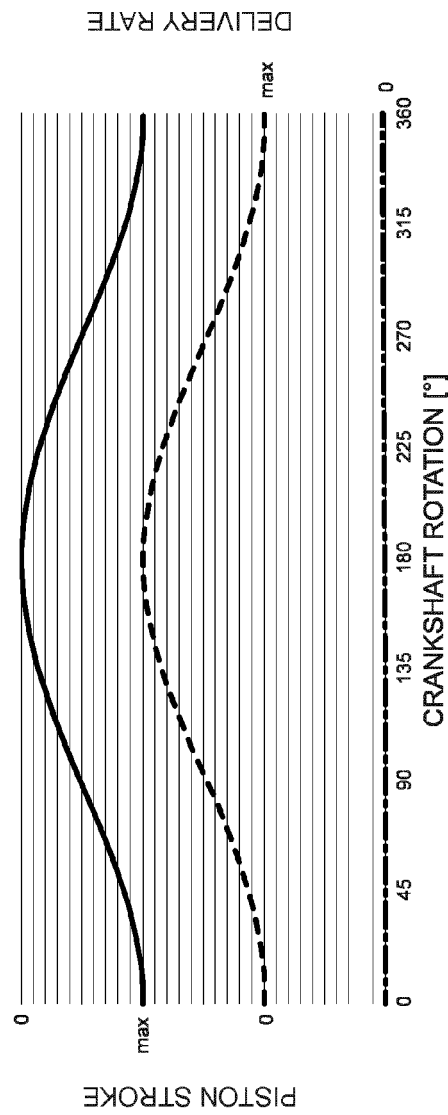


FIG. 6





EUROPEAN SEARCH REPORT

Application Number

EP 23 15 7172

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EPO FORM 1503 03:82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 12 May 2023	Examiner Zupancic, Gregor
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	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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