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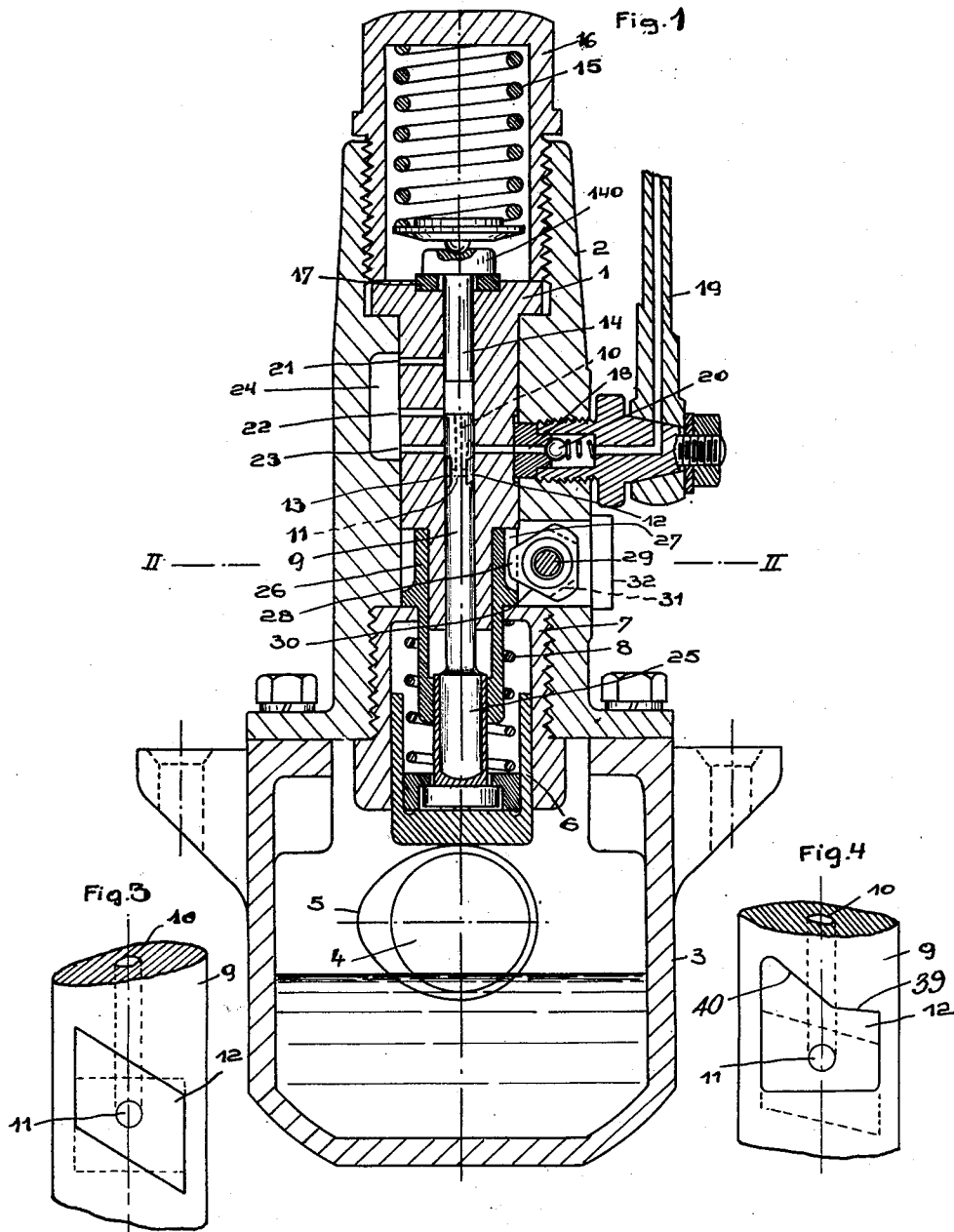
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2,225,019

INJECTION DEVICE FOR COMBUSTION ENGINES

Filed Jan. 8, 1936

2 Sheets-Sheet 1



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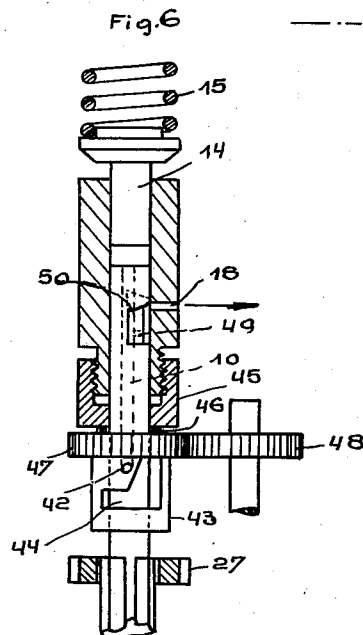
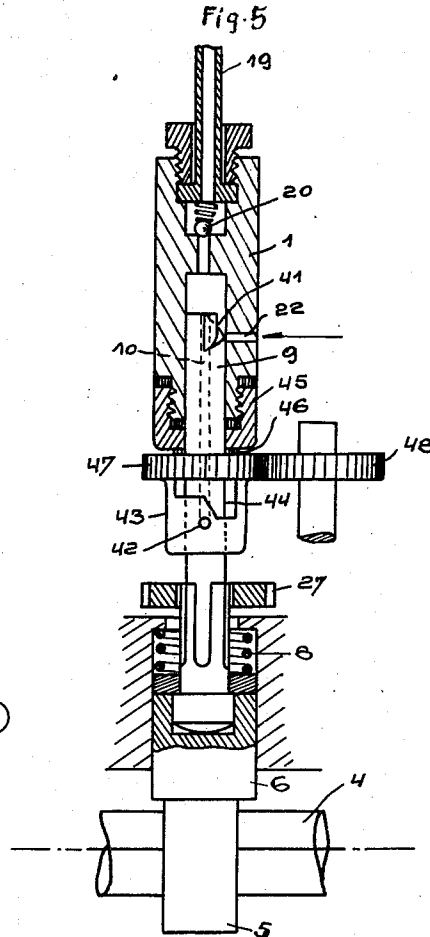
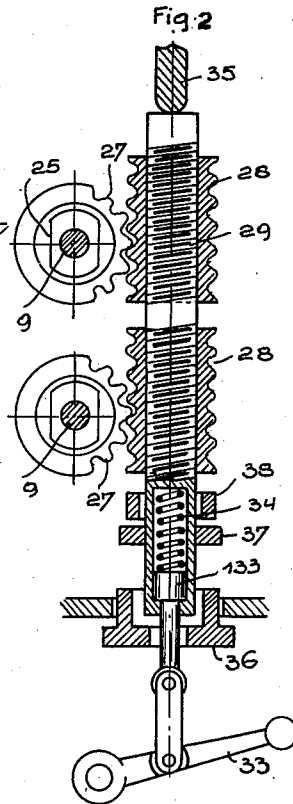
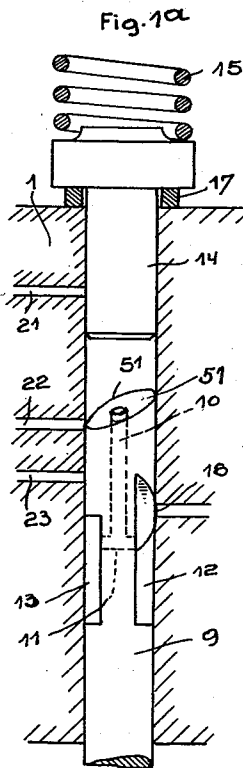
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INJECTION DEVICE FOR COMBUSTION ENGINES

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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INJECTION DEVICE FOR COMBUSTION
ENGINES

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7 Claims. (Cl. 123—139)

The present invention relates to pumps for the injection of a certain amount of liquid fuel into the cylinders of internal combustion engines.

One of the objects of the present invention is to provide a pump of this type in which the time at which injection is started is variable according to the charge of fuel and to the speed of revolution of the engine, so as to obtain an advantageous working of said engine for any charge and any speed of revolution thereof.

Another object of the present invention is to provide a pump of the kind above referred to in which the position of the organ controlling the beginning of injection depends, for a given amount of fuel injected, upon the speed of revolution of the engine.

Other features of the present invention will result from the following description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described with reference to the accompanying drawings, given merely by way of example and in which:

Fig. 1 is an axial sectional view of a first embodiment of the invention; Fig. 1^a shows a modification;

Fig. 2 is a transverse sectional view of said pump on the line II—II of Fig. 1;

Fig. 3 shows, on an enlarged scale, a detail of the pump of Figs. 1 and 2;

Fig. 4 shows a modification of the detail illustrated by Fig. 3;

Fig. 5 is an axial sectional view of a second embodiment;

Fig. 6 is a view, analogous to Fig. 5, showing still another embodiment.

In the embodiment of Fig. 1, the cylinder 1 of the pump fits in a bore provided in a block 2 the bottom of which is fixed to casing 3. This casing contains an oil bath for a shaft 4 driven by an engine and which drives a push piece 6 through a cam 5. This push piece is guided in a sleeve 7 screwed to the lower part of block 2. It is subjected to the action of a return spring 8, which pushes it downwardly and it is connected to the piston 9 of the pump in such manner as to permit a rotation of said piston about its axis.

The opposite end of piston 9 is provided with a central channel 10, leading to a transverse conduit 11, the respective ends of which open into a recess 12 and a recess 13, provided, in diametrically opposed positions, in the periphery of piston 9. These two recesses have equal areas, in order to balance the lateral effects of the pressure on the piston. In the example shown by Fig.

3, the transverse edges of recess 12 are oblique with respect to the axis of piston 9, while the corresponding edges of recess 13 are at right angles to said axis.

The upper end of cylinder 1 is closed by a plunger 14 subjected to the action of a return spring 15, which is housed in the screwed cap 16 of block 2. Plunger 14 is provided with a head 140 which, in the position of rest bears upon an annular member 17, of well determined thickness.

Cylinder 1 is provided with a delivery conduit 18 connected to the injector (not shown in the drawings) through a conduit 19, under the control of check valve 30. The orifice of this passage 18 is uncovered when the upper edge of the recess 12 of piston 9 moves past said orifice, in the upward movement of said piston.

Three other passages 21, 22, and 23 provided in cylinder 1 open into a chamber 24 provided in block 2, said chamber being connected to a fuel tank (not shown in the drawings). Passage 22 is the suction passage of the pump. It is intended to cooperate with the upper edge of piston 9. Passage 21 is a leakage conduit, placed under the control of plunger 14. Passage 23 is also a leakage conduit, the orifice of which is controlled by the upper edge of the recess 13 of piston 9. The lower part of said piston is provided with parallel flat faces 25, fitting against corresponding flat faces provided in the inner surface of a sleeve 26 capable of rotating freely with respect to the lower part, of reduced diameter, of cylinder 1, and prevented from moving in the longitudinal direction. Sleeve 27 is provided with external teeth 27 located above sleeve 7. These teeth are in mesh with a rack 28, screwed on a rod 29 extending transversely to piston 9 and movable in the direction of its own axis.

If, as shown by Fig. 2, the pump includes a plurality of pistons, there is one rack 28 for each piston. Each of these racks consists of a cylinder having circular grooves of the desired profile formed in the periphery thereof, with flat faces 30, cut at 120° from one another, and, close to one end, other flat faces 31, making an angle of 60° with the first mentioned flat faces 30. This arrangement of racks 28 screwed on a rod 29 makes it possible to accurately adjust the relative position of said racks on said rod.

The flat faces 30, 31 above mentioned facilitate the operation of adjustment, which is performed by means of a spanner. Once the racks have been adjusted in a predetermined position, they are prevented from moving out of adjustment by means of a plug 32, having a flat face parallel to

one of the faces 30 above mentioned and located close thereto.

The axial position of rod 29 is adjustable axially, through a lever 33. The latter acts on push piece 133, which in turn controls the displacements of rod 29, through a spring 34. At the opposite end of rod 29 there is provided a push piece 35 which permits of bringing the engine into idling working, without acting on lever 33, owing to the provision of spring 34. The displacement of rod 29 is limited in this direction by stop ring 36, the position of which is variable in order to permit of adjusting the idling.

It may also be desired to bring the engine into idling working when it reaches a predetermined speed of revolution. I may, for instance, for this purpose provide a fork 38 adapted to act on a collar 37 of rod 29, said fork being controlled by a centrifugal governor (not shown in the drawings) operated by the engine.

The control of the injection is effected in the following manner:

Piston 9 exerts a compression on the liquid fuel when the upper edge of said piston covers passage 22. The fuel lifts plunger 14 until the latter uncovers the orifice of the upper passage 21. The upper edge of the recess 12 of piston 9 then uncovers the orifice of the passage 18 leading to the injector. Injection takes place, while plunger 14 is moving back toward its stop 17. It lasts until the upper edge of the recess 13 of piston 9 opens the orifice of the lower by-pass conduit 23.

In view of the fact that the active edge of recess 12 is inclined, it is quite clear that the time at which injection starts depends upon the angular position of piston 9 about its axis, which position can be manually adjusted, according to the charge of fuel to be supplied to the engine. On the other hand, the time that elapses between the time of opening of the orifice of passage 18 and the time of opening of by-pass passage 23 depends upon the speed of revolution of the engine.

For a given charge to be supplied to the engine, it is necessary to turn piston 9 about its axis, in the direction that corresponds to earlier injection, through an angle which is the greater as the speed of revolution of the engine is the higher. The advance to injection therefore depends both upon the speed of revolution of the engine and upon the charge of fuel.

In order to obtain a higher sensitiveness of the device at small speeds of revolution, and a more considerable lead to injection for high speeds and charges, I may, as shown by Fig. 4, give the active edge of recess 12, a double angle of inclination, 39-40, the smaller inclination corresponding to small charges of fuel. The active edge of recess 13 may also be made more or less oblique with respect to the axis of piston 9.

In the embodiment of Fig. 5, the passage 18 through which fuel is fed to the injector is provided at the upper end of the cylinder. It is controlled merely by check valve 20. The inlet passage 22 is controlled by the bottom of an inclined notch 41 starting from the upper edge of piston 9. The axial conduit 10 of the piston extends downwardly to the outside of the cylinder and opens at 42 into the outer face of the piston, at the end of a transverse branch. Orifice 42 cooperates with a sleeve 43, adapted to turn freely with respect to the piston and prevented from moving longitudinally with respect to said piston. This sleeve is provided with an aperture 44 the lower edge of which includes a portion oblique

with respect to the axis of the piston, between two portions at right angles to said axis. Sleeve 43 may be displaced longitudinally, for adjustment purposes, by means of nut 45, which is screwed on the bottom of cylinder 1, or through the interposition of annular elements 46, the thickness of which varies according to the desired adjustment of the interval between the upper face of sleeve 43 and nut 45.

Sleeve 43 is provided with external teeth 47, in mesh with the teeth of a pinion 48, which is adapted to turn under the action of a centrifugal governor or any other device responsive to the speed of revolution of the engine.

Piston 9 drives fuel to the injector, through passage 18, when the bottom of its notch 41 moves past suction orifice 22. Injection ceases when orifice 42 is uncovered by the aperture 44 of sleeve 43. In this case also, the beginning of the injection depends upon the angular position of piston 9 about its axis. For a predetermined charge to be injected to the engine, this angular position of piston 9 is itself a function of that of sleeve 43, which in turn depends upon the speed of revolution. The lead to injection therefore depends upon both the charge of fuel and the speed of revolution of the engine.

The same is true for the embodiment of Fig. 6. In this case, the suction of fuel takes place during the forward stroke of piston 9, through orifice 42 which, during the return stroke of the piston, constitutes a leakage orifice, placed under the control of sleeve 43. The upper end of cylinder 1 consists, in this case, as in the embodiment of Fig. 1, of a plunger 14, subjected to the action of a return spring 15. The axial passage of piston 9 is provided with a second transverse branch 49, opening into a recess 50 of said piston. The upper edge of this recess, which is inclined with respect to the axis of piston 9 controls the orifice of the passage 18 through which fuel is fed to the injector.

The delivery of the pump begins when the leakage orifice 42 comes opposite a solid portion of sleeve 43. It produces an upward movement of plunger 14. The beginning of injection takes place when the upper edge of recess 50 uncovers the orifice of passage 18. Injection ceases when piston 14 has come back against its seat.

All the pumps according to these embodiments automatically stabilize the speed of revolution of the engine. This is due to the fact that, when this speed tends to increase, sleeve 43 moves in the direction which corresponds to a decrease of the amount of fuel injected, the reverse action taking place if the speed of the engine tends to decrease (Figs. 5 and 6). Similar effects are obtained with the embodiment of Fig. 1, as a consequence of the variations resulting, for the speed of movement of piston 9, from variations of the speed of revolution of the engine.

With the embodiments of Figs. 5 and 6, it is easy to limit the maximum rate of feed of fuel by longitudinally displacing sleeve 43, through a displacement of nut 45 or by changing the thickness of annular elements 46.

With the embodiment of Figs. 1 to 4, the same adjustment is obtained by making use of annular members 17 of different thicknesses, which modifies the distance between the lower edge of the plunger and the discharge orifice 21 which it uncovers during the delivery of the pump.

In the case of engines intended to run at very high speeds, the arrangement shown by Figs. 1 to 4 may be modified as shown in Fig. 1^a so that,

at these speeds of revolution, the inclined active upper edge of recess 12, provided in piston 9, uncovers the orifice of passage 18 before the orifice of passage 22 has been covered by the upper inclined end of piston 9. This arrangement is shown by Fig. 1^a.

The inertia of plunger 14 produces, when the orifice of passage 22 is subsequently closed, a sudden rise of the injection pressure. This rise of pressure may be useful at very high speeds. In this case, the lead to injection is controlled by the upper edge of piston 9 which is given an inclined shape, as shown at 51 in Fig. 1^a.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition, and form of the parts, without departing from the principle of the present invention as comprehended within the scope of the appended claims.

What I claim is:

1. In a pump adapted to work in connection with an internal combustion engine, for the injection of fuel to said engine, the combination of a cylinder, a piston movable in said cylinder, means for reciprocating said piston in said cylinder, said piston being provided with an axial conduit opening into one end face thereof and into the lateral surface of said piston near the other end thereof, this last mentioned end of the piston projecting from said cylinder and being adapted to be immersed in fuel, a sleeve surrounding said last mentioned end of the piston provided with an aperture having at least one inclined edge adapted to cooperate with the second mentioned opening of said axial conduit of the piston, means for angularly displacing said sleeve in response to variations in the speed of revolution of the engine, a delivery passage in the lateral wall of said cylinder, said piston being provided with a recess having at least one inclined edge adapted to cooperate with said passage and communicating with said axial conduit, a plunger slidable in said cylinder closing the end thereof that corresponds to the first mentioned end of said piston, and elastic means for urging said plunger into said cylinder, and means for adjusting the angular position of said piston about its axis in said cylinder.

2. In a pump operating in connection with an internal combustion engine for injecting fuel to said engine, the combination of a cylinder open at both ends, a piston operating in said cylinder through one of its ends, a spring loaded plunger entering the other end of said cylinder, an inlet in the wall of said cylinder controlled by the inner end of said piston, said piston having two cavities in its cylindrical surface, one of said cavities having at least one edge oblique to the generatrices of said piston, passage means between said cavities and the space between said plunger and said piston, a delivery opening adapted to cooperate with the oblique edge of said first mentioned cavity for injection purposes, a by-pass in the wall of said cylinder adapted to cooperate with the other cavity in order to discharge the space between said piston and said plunger so as to stop the injection of fuel, and means for rotating said piston about its axis, the edge of the inner end of said piston being oblique and located at such a distance from the oblique edge of said first mentioned cavity of said piston that said inlet is only covered by said piston after

the opening of said delivery opening by said cavity.

3. In connection with an internal combustion engine having fuel injection means, a pump for feeding fuel to said injection means which comprises, in combination, a chamber having a spring loaded outwardly yielding wall, means for forcing under a limited pressure into said chamber, at each stroke of the pump, an amount of fuel greater than the maximum to be injected at one stroke, and means, operative by the engine and adjustable in operation, for connecting said chamber with said fuel injection means for a time inversely proportional to the speed of said engine.

4. In connection with an internal combustion engine having fuel injection means, a pump for feeding fuel to said injection means which comprises, in combination, a chamber having a spring loaded outwardly yielding wall, means for forcing under a limited pressure, into said chamber, at each stroke of the pump, an amount of fuel greater than the maximum to be injected at one stroke, means, operative by said engine, for connecting, at each stroke, said chamber with said fuel injection means, so as to start injection, means, operative by said engine, for discharging said chamber to the outside, so as to stop injection, a certain time after the starting thereof, said time being inversely proportional to the speed of said engine, and means for adjusting in operation the two last mentioned means so as to permit of varying both the time of starting of injection and the duration of injection.

5. In connection with an internal combustion engine having fuel injection means, a pump for feeding fuel to said injection means which comprises, in combination, a chamber having a spring loaded outwardly yielding wall, means for forcing under a limited pressure into said chamber, at each stroke of the pump, an amount of fuel greater than the maximum to be injected at one stroke, and slide valve means, driven by said engine, for first connecting, at each stroke, said chamber with said fuel injection means, so as to start injection, and subsequently discharging, at a farther point of its stroke, said chamber to the outside, so as to stop injection, whereby the duration of injection is inversely proportional to the speed of said slide valve means and therefore to the speed of said engine.

6. In connection with an internal combustion engine having fuel injection means, a pump for feeding fuel to said injection means which comprises, in combination, a cylinder, a spring loaded plunger forming one end of said cylinder, a piston driven by said engine movable in said cylinder, a port in the wall of said cylinder communicating with a source of fuel adapted to cooperate with the inner end of said piston, a by-pass port in the wall of said cylinder between said first mentioned port and the end of said cylinder fitted with said plunger, for the outflow of the excess of fuel forced between said piston and said plunger, whereby a too large amount of fuel is placed under a limited pressure in said cylinder between said piston and said plunger for each inward stroke of said piston, said piston being provided with two cavities in its cylindrical wall, one of said cavities being nearer the inner end of the piston than the other, said piston being provided with a longitudinal passage opening at one end into its inner end and at the other end into both of said cavities, a delivery port in the wall of said cylinder communicating with said injection means adapted to communicate with

the first mentioned cavity, and a discharge port in the wall of said cylinder adapted to cooperate with the other cavity after said first mentioned cavity has come opposite said delivery port.

- 5 7. In connection with an internal combustion engine having fuel injection means, a pump for feeding fuel to said injection means which comprises, in combination, a cylinder, a spring loaded plunger forming one end of said cylinder, a piston driven by said engine movable in said cylinder with a reciprocating motion at a speed proportional to that of said engine, a port in the wall of said cylinder communicating with a source of fuel adapted to cooperate with the inner end of said piston, a by-pass in the wall of said cylinder between said first mentioned port and the end of said cylinder fitted with said plunger, for the outflow of the excess of fuel forced between said piston and said plunger, whereby a too large amount of fuel is thus placed
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under a limited pressure in said cylinder between said piston and said plunger for each inward stroke of said piston, said piston being provided with two cavities in its cylindrical wall, one of said cavities having at least its edge nearer to the inner end of said piston directed obliquely to the generatrices of said piston, said piston being further provided with a longitudinal passage opening at one end into its inner end and at the other end into both of said cavities, a delivery port in the wall of said cylinder communicating with said injection means adapted to cooperate with said first mentioned cavity, a discharge port in the wall of said cylinder adapted to cooperate with the other cavity after said first mentioned cavity has come opposite said delivery port, and adjusting means for varying, in service, the angular position of said piston about its axis, in said cylinder.

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