VARIABLE CAPACITY FUEL INJECTION PUMP FOR FUEL COMBUSTION OPERATED PILE DRIVER

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ABSTRACT OF THE DISCLOSURE

In combination with a fuel injection device, especially for fuel combustion operable pile drivers, a control device which is adjustable each time by equal steps while the fuel injection device is operable independently of the stroke time and power of adjustment of said control device.

The present invention concerns a fuel combustion operable pile driver with a fuel injection pump which is adjustable in conformity with a predetermined delivery.

With pile drivers of the above-mentioned type, the delivery of the pump per stroke which determines the driving energy is, whenever desired, adjusted in an infinitely variable manner. Such stepless adjusting devices are known according to which the adjustment is effected by cables, by Bowden wires, or hydraulically.

It has been found that such stepless or infinitely fine adjustment, is unsatisfactory. This is due to the fact that the operator, when effecting an operation which is not very precise in view of the fact that it is stroke-dependent, or for other reasons, in numerous instances does not effect the adjustment in conformity with the change in the driving energy to such an extent that the optimum would be obtained in the respective instance. When reducing the driving energy to too great an extent, the pile driver stops, whereas when unduly increasing the driving energy, the member or object to be driven will be damaged.

It is, therefore, an object of the present invention to remedy the above-outlined drawbacks.

It is another object of this invention to provide a fuel combustion operable pile driver with a fuel injection pump in which the delivery of the pump can be adjusted so as to yield the optimum result for the respective situation encountered.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings.

FIGURE 1 diagrammatically illustrates a fuel pump for use in connection with the pile driver. FIGURE 2 further shows the means for adjusting the control member which determines the delivery of the injection pump.

It has been found, according to the present invention, that the above-outlined drawbacks will be avoided if means are provided which bring about that each adjustment can be effected only by short steps which cannot be exceeded by any handling, the total adjustment being adapted to be effected only by a repeated adjustment by such step gradually and without excessive control. Therefore, in conformity with the present invention, such fuel combustion operable pile drivers have the pump provided with a control device adjustable always by the same step regardless of the stroke time and force of adjustment.

If with such an adjustment of the delivery of the injection pump per pump stroke, it should be desired that the pile driver energy, which does not vary in conformity with the linear function relative to each step, is adjusted as linearly as possible, this may be realized according to a further development of the present invention according to which the adjusting device is equipped with a cam affecting the adjusting element of the pump for varying the delivery thereof. This arrangement is such that the dependency of the pile driver energy from the fuel delivery per pump stroke changes from step to step by the same amount.

Referring now to the drawing, the latter shows only diagrammatically the injection pump and the device for moving the adjusting element for the delivery of the injection pump, said device when being adjusted changing the delivery per pump stroke (FIG. 1 and FIG. 2).

Fuel passes from a fuel reservoir 11 through a conduit 12 and an inlet passage 13c in the pump housing 13 into the compression chamber proper 13b of the pump and also into an adjacent passage 13c having associated therewith a check valve 14 set for a certain pressure. In a cylinder 13d which forms the continuation of the compression chamber 13b there is reciprocally arranged a plunger 15 adapted to be actuated by a lever 17 pivotally supported by a pivot 18. A spring 27 continuously urges plunger 15 to move outwardly.

Disregarding the delivery adjustment, which will be explained further below, the fuel displaced by the plunger 15 during its inward movement by lever 17 passes through the check valve 14 and through a conduit 19 to the combustion chamber of the fuel combustion operated driver (not shown) where it is burned for the next driving stroke of the driver.

The passage 13c is continued by a passage 13d transverse to the passage 13c. A control piston 20 is displaceable in the said transverse passage 13d.

Passage 13d is closed toward the outside by a displaceable stopper 21 which also seals said passage 13d toward the outside. Stopper 21, by means of its inner surface, serves as abutment for the control piston 20. Under the influence of a spring 22 resting against an end face of said stopper 21, the control piston is urged against a shoulder 28 formed by a constriction 13e of the passage 13d. Disregarding the device for adjusting the stopper 21 within the passage 13d, which adjusting device will be described further below, the control piston acts in such a manner that the fuel leaving the reservoir 11 and passing into the chamber 13b and passages 13c, 13d is by means of the displacement of piston 20 to the abutment formed by stopper 21 pressed to a predetermined extent into the passage 13d, and only the remainder is ejected through check valve 14 as stroke delivery into the conduit 19 leading to the combustion chamber of the pile driver. Depending on how deep the stopper 21 is pressed into the bore or passage 13d and held therein by the adjusting device, a different predetermined delivery depending on the displacement of the piston 20, is ejected.

The control piston 20 is each time by the spring 22 returned to its starting position when the plunger 15 has-
freed the inlet passage 13a, in which starting position piston 20 abuts shoulder 28. For purposes of adjusting the extent to which the stopper 21 is moved into the passage 13d, the arrangement is provided with a pulley 23 which, by means of a rope or cable 24 looped therearound may be turned about its axis between end abutments 23c, 23d in one or the other direction. The circumferential surface of the pulley 23 is further provided with (in this instance), a spiral abutment surface or cam surface 23a so that when the pulley 23 is turned the stopper 21 is pressed inwardly and when turned in the opposite direction, is under the influence of the spring 22 continuously engaging outwardly on the pulley 15 while engaging the cam surface 23a. In order always to bring about a stepwise turning of the pulley 23 by small steps, a pawl-ratchet mechanism is provided in a central recess of the pulley. This pawl-ratchet mechanism has associated therewith a predetermined number of directed teeth 23b with shoulders of the two pawls 25 pivoting about pivot pins 30. Each direction of rotation of the pulley 23 has associated therewith one of said pawls. These pawls 26 are in a non-illuminated manner so designed and arranged that when pulling on one strand of the actuating rope 24, the pulley 23 can with one of its teeth be turned below the end of a pawl 26, while the other end does not extend into the path of movement of the tooth. The pulley 26 may after the passage of this tooth be so rotated that its mentioned pawl end extends into the path of movement of the next tooth and the latter finally abuts the pawl end, while the pawl, when the pull on the rope is briefly interrupted, returns to a position in which its end pivots outwardly off the path of the respective tooth abutting this end, and this tooth can again be moved below the ratchet.

The pulley 23 runs about an axis 34 in a housing that is not shown. The pawls 26, having pivot axes 25 firmly established in the housing, are also provided with auxiliary control levers 29. These control levers 29 are swingable at the ends of the pawls 26 about the pivot pins 30 which journal the pawls. The one end of the control lever extends in a nose-like manner into the area of a locking tooth, ratchet or detent 23b, without, however, extending into the path of movement of this detent 23b in a rest condition. The control levers project in a rest condition of the detent drive on their parts likewise in a nose-like manner into the area of a locking tooth or detent 23b, whereby in this case the control lever in rest condition extends into the path of movement of these locking teeth 23b. A V-shaped pin 31, being secured to a housing, Lawson with the outwardly bent ends 31a thereof against the control lever 29 so that the contact surface 29a of the control lever lies against an opposing contact surface 26a of the control lever. In the illustrated example it is to be understood that by pulling along the left strand of the rope 24 there is turning of the pulley 23 in the direction of an arrow A. Hereby the left control lever 29 shown in the drawing meets with the next corresponding locking tooth 23b and during further turning in the direction of the arrow A swings the control lever 29 into a position shown in phantom in the drawing. The locking tooth just noted can pass freely along the pawl 26. After the passage of the control lever 29 snaps back under urging of the spring into its fully extended starting position. During this first swinging in the direction of the arrow A the nose-formed end of the right control lever or pawl 26 has positioned itself in the illustrated rest position, thus the lowest locking tooth 23b is moved below this nose end. Thereafter a locking tooth 23b engages upon an inclined ramp 29b of the right control lever 29 and swings the same together with the corresponding control lever about the axis 25 against the urging of the spring 31 in the phantom-drawn position in a space between that in the rest position of the lowermost locking tooth 23b and the left neighboring locking tooth thereof, because the locking tooth 23b located below in the drawing has already passed the nose during the beginning of the turning operation. The left neighboring locking tooth then engages upon the swing-in, contact surface 23c of the right pawl 26. Thereby the pulley is turned by one tooth-pitch. Upon reaching this contact position the pull at the left strand of the rope 24 is interrupted, thus the pawl 26 and the control lever 29 provided therein swing back under force of spring 31 in the drawn position of the parts shown by full lines, corresponding to the rest position. This step shifting can be repeated as often as desired, until the pulley 23 strikes with its abutment 23c against the stopper 21. Also in the opposite direction it is possible to shift stepwise at tooth-pitch intervals, whereby the spring operation described for the right shift- and control lever 26 and 29, respectively, occurs for the left shift- and control lever 26 and 29, respectively.

In this way, it is possible by repeated interrupted pulling on a rope section of rope 24 to turn the rope pulley 23 always only by steps and, more specifically, by one tooth-pitch.

A more detailed description of the pawl-ratchet mechanism appears to be superfluous, because pawl-ratchet mechanisms of the type involved are well known as to their construction and operation, and are available in numerous designs. The specific design of the pawl-ratchet mechanism does not teach the invention proper.

What I claim is:

1. In combination with a fuel injection device comprising housing means having inlet passage means for connection with a fuel supply, outlet passage means with check valves means therein for releasing fuel to a combustion chamber, and conduit means interconnecting said inlet and outlet passage means and including compression chamber means and first plunger means reciprocable in said compression chamber means for subjecting fluid therein to pressure; a control device which includes: cylinder means communicating with said conduit means and including first abutment means, fluid operable second plunger means reciprocable in said cylinder means and operable by fuel under pressure in said conduit means, second abutment means adjustable arranged in said cylinder means for limiting the stroke of said second plunger means in said cylinder in one direction thereby said abutment means limiting the stroke of said second plunger means in said cylinder in the opposite direction, spring means adjacent said second plunger means and continuously urging the same into abutment with said first abutment means away from said second abutment means, and adjusting means associated with said second abutment means movable by steps independently of the movement of said first plunger means in said cylinder, said adjusting means including: rotatable cam means engaging said second abutment means, pawl-ratchet means operatively connected to said cam means with the ratchet teeth of the circumferential length, said pawl-ratchet means being operable in either direction, and means operatively connected to said cam means for selectively rotating the same in either direction, the curvature of said cam means being such that the quantity of fuel delivered by said first plunger means per stroke through said check valve means changes by the same amount step to step when actuating said pawl-ratchet means.

2. An arrangement according to claim 1, which includes: spring means interposed between said second abutment means and said second plunger means and continuously urging the latter toward said first abutment means.

3. An arrangement according to claim 1, which includes: additional spring means associated with said first
plunger means for continuously urging the same to move in a direction out of said compression chamber, and actuating lever means operatively connected to said first plunger means for moving the same into said compression chamber means against the thrust of said additional spring means.

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