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(54) **A FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES, IN PARTICULAR BIG, SLOW MARINE DIESEL ENGINES**

BRENNSTOFFEINSPRITZPUMPE FÜR VERBRENNUNGSMOTOREN, INSBESONDERE LANGSAMLAUFENDE GROSSDIESELMOTOREN FÜR DIE SCHIFFAHRT

POMPE D'INJECTION DE CARBURANT POUR MOTEURS A COMBUSTION INTERNE, EN PARTICULIER DE GROS MOTEURS DIESEL LENTS FONCTIONNANT EN MILIEU MARIN

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US-A- 4 957 418
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Description

[0001] The present invention relates to a fuel injection pump for internal combustion engines, in particular big, slow marine diesel engines, for supply of a variable amount of fuel to an injection nozzle positioned in the working cylinder of the engine, said injection nozzle having a spring-loaded needle in the nozzle aperture, and which pump comprises a barrel, in which a plunger with an upper edge formed between the end surface and the side surface of the plunger and at least one helically extending oblique cut-off edge, is movable, which oblique cut-off edge defines a recess in the side surface of the plunger, which recess is connected through an axial duct with the end surface of the plunger, and in which the wall of the barrel has separate sets of holes for controlling the beginning and the end of the effective pump stroke, which holes opens into a surrounding supply chamber containing the fuel under moderate pressure, said holes comprising a timing hole which at the travel of the plunger from the bottom to the top position is covered by the side surface of the plunger below the upper edge, and a relief hole being later uncovered by the oblique cut-off edge for diversion of excess fuel at the end of the effective pump stroke, and in which at least some of the holes are provided with an orifice member with an aperture reduced relative to the cross section of the hole for providing, during a part of the travel of the plunger, an increased static pressure in these holes.

[0002] In conventional fuel injection pumps each oblique cut-off edge is matched by a hole through the wall of the barrel, and the plunger is designed such that this hole at the beginning of the travel of the plunger is covered by the upper edge of the plunger, and the same hole is later exposed by the oblique cut-off edge, when the set amount of fuel has been supplied to the injection nozzles. Such an arrangement has worked satisfactorily in small and mediumsized engines, but in big, slow diesel engines problems arise which can be traced back to the big dimensions of the pumps and to measures, which have to be taken in order to dampen pressure variations in the injection system at the start and at the end of the effective pump stroke. The problems may be erosion on the side surfaces of the plunger stemming from cavitation in the holes on account of high flow velocity. An increase of the cross section of the holes can, however, not be made straight away, as the holes, when uncovered by the oblique cut-off edge, are to delay the pressure relief by exerting a certain flow resistance. This delay is necessary in order to prevent cavitation in the nozzles and to prevent combustion gas from entering the injection nozzles. It is also desirable, if possible, to obtain a comparatively big bearing surface between plunger and barrel in the area at the upper edge of the plunger to reduce the risk of seizures in this area, when fuel with inferior lubricating properties is used.

[0003] An injection pump of the abovementioned type is disclosed in US-A-4118156. The means for increasing the static pressure in the cut-off holes are spring loaded valves controlling the flow of fuel into and out from the supply chamber. The arrangement is complicated and requires high power consumption from the pump supplying fuel to the supply chamber.

[0004] Other arrangements for increasing the static pressure in the cut-off holes are described in German Offenlegungsschrift no. 25 32 205 and US-A-5 015 160.

[0005] US-A-4 957 418 discloses a fuel injection pump having a plunger cooperating with cut-off holes in a barrel and in which the means to provide an increased static pressure in the cut-off holes are accommodated in one of the cut-off holes. The means comprise a restrictive orifice placed in the hole, the closure of which initiates the injection stroke initiating the relief at the end of the stroke. This knowm arrangement leads to a lateral pressure on the plunger, which in case of fuels with poor lubricating properties may lead to increased wear on the plunger.

[0006] The object of the invention is to provide a fuel injection pump af the type defined in the opening clause of the claim and in which erosion at the top of the plunger is eliminated and which may be used for fuels with poor lubricating properties and which is of simple construction. This object is met according to the invention thereby that the pump is characterized in that the orifice member is placed in the set of timing holes only.

[0007] The invention relates to fuel injection pumps, in which the beginning and the end of the effective pump stroke is controlled by means of separate sets of holes. With this combination of features is obtainable that the plunger obtains a comparatively large bearing surface and that the shape and the size of the openings in the barrel, which openings are being covered and uncovered by the plunger, may have optimized dimensions, and finally that orifice members do not cause any unbalanced pressure on the plunger.

The construction according to the invention has proved to eliminate erosion on the plunger and to reduce wear on the the plunger cooperating with the cut-off holes in form of a set of timing holes and a set of relief holes.

[0008] The invention will now be described in detail with reference to the drawing, in which

Fig. 1 is an axial view through a fuel injection pump according to the invention,

Fig. 2 is a sectional view of a cross section through the wall of the barrel along the line II-II according to Fig. 1,

Fig. 3 is a diagram showing the pressure in the pump according to the invention during a fuel injection, and

Figs 4a, 4b, and 4c schematically show cut-off holes in a longitudinal, sectional view.

[0009] The fuel injection pump 1, shown in axial view in Fig. 1, comprises a barrel 2, in which a plunger 3 is movable. The barrel 2 is adapted to be built into a pump

housing of conventional design, which comprises a supply chamber surrounding the middle portion of the barrel and to which excess fuel may be diverted, and from where, during the course of the return stroke of the plunger, fuel may be supplied to the barrel. The plunger 3 comprises an upper edge 4 formed between the end and side surfaces of the plunger. The plunger, moreover, comprises a recess 5, which in the direction of the end surface of the plunger is defined by an oblique cut-off edge 6 extending helically along the side surface of the plunger. The oblique cut-off edge 6 covers an angle of for instance 120°, and normally a plunger is provided with two oppositely positioned cut-off edges 6. The plunger 2 is provided with coupling means 7 for a rotating mechanism, by means of which the plunger may be rotated for adjustment of the delivery amount, and coupling means 8 for a roller guide adapted to move the plunger axially. These mechanisms are not part of the invention and may be conventionally designed. The plunger 3 also comprises an axial duct 9 connecting the recess 5 with the space 10 above the end surface of the plunger 4.

[0010] The pump is adapted to deliver a variable amount of fuel to the injection nozzles in the working cylinders of a diesel engine. The delivery amount is adjusted by rotating of the plunger 3. The effective pump stroke is initiated by the fact that the edge at the end surface 4 of the plunger during its upwards movement covers a set of timing and cut-off holes 11 in the barrel 2 of the pump, and the effective pump stroke ends, when the oblique cut-off edge 6 uncovers a set of relief holes 12, whereby the pressure in the pump chamber above the end surface 4 of the plunger is relieved through the axial duct 9, the recess 5 and the cut-off holes 12 to the supply chamber surrounding the barrel 2.

[0011] In fuel injection pumps for big, slow diesel engines, for instance for marine use, special problems arise on account of the big dimensions of the pump and the high pressures, at which the fuel is injected, said problems being met by the pump described by use of separate, specifically designed timing holes and relief holes in the beginning and at the end of the effective pump stroke. By using separate sets of holes, the timing holes can be designed such that cavitation stemming from disruption of the flow of fuel, which is expelled at big velocity, is effectively prevented, the relief holes are designed such that a suitable dampening of the diverted fuel is obtained, until the risk of pressure oscillations, which may lead to penetration of cylinder gasoline into the injection nozzles, has been overcome, or such that cavitation in the injection nozzles is prevented. Moreover, the bearing surface between the upper portion of the plunger and the wall of the barrel may be given a proper size by an appropriate dimensioning of the axial spacing between the holes 11 and 12.

[0012] The timing holes are conventionally designed with bigger cross section than the relief holes 12. The cavitation may, however, according to the invention be most effectively prevented by placing an orifice member 13 at the outlet of the timing hole to the supply chamber, as shown in Fig. 2. The orifice member provides such a flow passage that the pressure in the timing hole in front of the orifice member substantially exceeds the pressure in the supply chamber immediately before the cut-off hole is covered, when the edge of the end surface 4 of the plunger passes. The flow resistance in the orifice member leads to such a retarded breaking down of the pressure at the side surface of the plunger that no cavitation occurs.

[0013] The relief holes 12, which are uncovered by the oblique cut-off edge 6, are normally designed with a longitudinal profile in the shape of a diffusor and are provided with the smallest cross section at the wall of the barrel. The small cross section at the wall of the barrel is desirable in order to obtain a quick exposure of the hole 12 and thus a well-defined pressure relief sequence in the injection system.

[0014] The diagram in Fig. 3 shows the pressure sequence in a fuel injection pump according to the invention drawn as a function of the crank angle. The fully drawn curve indicates the pressure in the pump chamber 10. The curve shows that the pressure in the pump chamber starts to increase as soon as the plunger 3 is moved upwards, but the steep increase starts at 14, where the timing holes 11 are covered by the plunger below its upper edge 4. At 15 the injection nozzles are opened, and at the continued pump stroke the set amount of fuel is injected in the working cylinder of the engine. At 16, the cut-off holes are uncovered, following which the pressure in the pump chamber falls in a dampened course, which counteracts pressure oscillations in the injection system and thus ensures a correct closing function of the needles in the injection nozzles. A dotted line 17 shows the pressure sequence in the chamber between the orifice member and the side of the plunger, the chamber being provided with an appropriately dimensioned orifice member 13. It will be seen that a gradual pressure fall can be obtained, said pressure fall effectively preventing cavitation in the side hole adjacent to the plunger side.

[0015] Figs 4a, 4b and 4c show schematic embodiments of cut-off holes, viewed in longitudinal section. Fig. 4a thus shows an embodiment, in which the flow-limiting means in the shape of an orifice member 21 is placed in a cut-off hole 20 close to its outlet 22 into the supply chamber. In this embodiment maximum size of the chamber, which is pressurized by cut-off and relief, and consequently the biggest possible volume in the chamber between orifice member and inlet and thus the best possible pressure maintenance is obtained. The orifice member may be designed with several ducts or with a flow direction of the ducts under an angle relative to the axis of the cut-off hole. An advantage of the ducts forming an angle with the axis of the cut-off hole is that the fluid relieved does not get perpendicularly in touch with an opposite supply chamber wall, and that the risk

of erosion of said wall is reduced. The chamber between the wall of the barrel and the orifice member may, moreover, have a non-cylindrical shape. The shape may for instance be conical such that the cut-off aperture in the wall of the barrel is somewhat smaller than the diameter of the chamber, in which the orifice member has been inserted. In this way the flow-controlling effect is distributed to the hole in the wall of the barrel and to the orifice member, which may be advantageous, if there are no separate timing and cut-off holes.

[0016] In Fig. 4b the orifice member 23 is positioned approximately in the middle of the hole 20, which results in a smaller chamber, but also in a bigger distance from the orifice member 23 to the opposite wall of the supply chamber, where the liquid flowing from the orifice member may cause erosion.

[0017] Fig. 4c shows a preferred embodiment of a cut-off hole 20 provided with an orifice member. The orifice member 24 is positioned substantially in the middle of the cut-of hole which in the direction towards the outlet 22 to the supply chamber is designed as a diffusor 25. The object of the diffusor 25 is to reduce the velocity of the jet leaving the orifice member. Through a suitable dimensioning of the orifice member 21, 23 or 24, such a building up of pressure in front of the orifice member at the cut-off may be obtained when the cut-off hole is covered that the cavitation risk is eliminated, and such a dampening of the relief is obtained that the break down of pressure may take place without substantial pressure oscillations. An additional dampening may, if desired, be established by a suitable design of the axial duct in the plunger.

Claims

1. A fuel injection pump for internal combustion engines, in particular big, slow marine diesel engines, for supply of a variable amount of fuel to an injection nozzle positioned in the working cylinder of the. engine, said injection nozzle having a spring-loaded needle in the nozzle aperture, which pump comprises a barrel, in which a plunger with an upper edge formed between the end surface and the side surface of the plunger and at least one helically extending oblique cut-off edge, is movable, which oblique cut-off edge defines a recess in the side surface of the plunger, which recess is connected through an axial duct with the end surface of the plunger, and in which the wall of the barrel has separate sets of holes for controlling the beginning and the end of the effective pump stroke, which holes open into a surrounding supply chamber containing the fuel under moderate pressure, said holes comprising a timing hole which at the travel of the plunger from the bottom to the top position is covered by the side surface of the plunger below the upper edge, and a relief hole being later uncovered by the oblique cut-off edge for diversion of excess fuel at the end of the effective pump stroke, and in which at least some of the holes are provided with an orifice member with an aperture reduced relative to the cross section of the hole for providing, during a part of the travel of the plunger, an increased static pressure in these holes,
characterized in that the orifice member is placed in the set of timing holes only.

Patentansprüche

1. Brennstoffeinspritzpumpe für Verbrennungsmotoren, insbesondere langsamlaufende Großdieselmotoren für die Schiffahrt, zur Zufuhr einer veränderlichen Menge von Brennstoff an eine Einspritzdüse, die sich im Arbeitszylinder des Motors befindet, wobei die Einspritzdüse eine gefederte Nadel in der Düsenöffnung aufweist, wobei die Pumpe einen Zylinder umfaßt, in dem ein Plungerkolben mit einer oberen Kante, die zwischen der Endfläche und der Seitenfläche des Plungerkolbens gebildet ist und mindestens einer sich schraubenförmig erstreckenden schrägen Steuerkante, beweglich ist, wobei die Steuerkante eine Aussparung in der Seitenfläche des Plungerkolbens festlegt, wobei die Aussparung durch eine axiale Leitung mit der Endfläche des Plungerkolbens verbunden ist, wobei der die Wand des Zylinders getrennte Sätze von Löchern zur Kontrolle des Anfangs und des Endes des effektiven Pumpenhubs aufweist, wobei die Löcher gegenüber einer umgebenden Zufuhrkammer offen sind, die den Brennstoff unter moderatem Druck enthält, wobei die Löcher ein Taktungsloch umfassen, das bei der Bewegung des Plungerkolbens von der unteren zur oberen Position von der Seitenfläche des Plungerkolbens unter der oberen Kante bedeckt ist, sowie ein Entlastungsloch, das später durch die schräge Steuerkante zur Ableitung von überflüssigem Brennstoff am Ende des effektiven Pumpenhubs freigelegt wird, und wobei mindestens einige der Löcher mit einem Mündungsglied mit einer Öffnung versehen sind, die bezüglich des Querschnittes des Loches verkleinert ist, um während eines Teils der Bewegung des Plungerkolbens einen erhöhten statischen Druck in diesen Löchern bereitzustellen, **dadurch gekennzeichnet, daß** das Mündungsglied nur bei den Taktungslöchern vorgesehen ist.

Revendications

1. Pompe d'injection pour moteurs à combustion interne, en particulier de gros moteurs diesel lents fonctionnant en milieu marin, destinée à fournir une quantité variable de carburant à un injecteur de car-

burant placé dans le cylindre moteur, ledit injecteur de carburant comprenant dans son ouverture une aiguille d'injection à rappel automatique, ladite pompe comprend une cuve d'aspiration dans laquelle peut se déplacer un piston plongeur comportant un bord supérieur formé entre la surface d'extrémité et la surface latérale du piston plongeur et au moins un bord découpé oblique, s'étendant de manière hélicoïdale, ce bord découpé oblique définit un évidement dans la surface latérale du piston plongeur, cet évidement est relié par l'intermédiaire d'un conduit axial à la surface d'extrémité du piston plongeur, et dans laquelle la paroi de la cuve d'aspiration comprend des ensembles indépendants de trous destinés à commander le début et la fin de la course effective de la pompe, ces trous débouchent dans une chambre d'alimentation périphérique contenant le carburant soumis à une pression modérée, lesdits trous comprenant un trou de synchronisation qui, lors de la course du piston plongeur entre la position inférieure et la position supérieure, est recouvert par la surface latérale du piston plongeur au-dessous du bord supérieur et un trou de décharge qui est découvert ultérieurement par le bord découpé oblique pour dévier le carburant en excès à la fin de la course effective de la pompe, et dans laquelle au moins certains des trous sont pourvus d'un élément formant orifice ayant une ouverture réduite par rapport à la section transversale du trou afin de fournir une pression statique plus importante dans ces trous pendant une partie de la course du piston plongeur,
caractérisé en ce que l'élément formant orifice est placé dans l'ensemble de trous de synchronisation uniquement

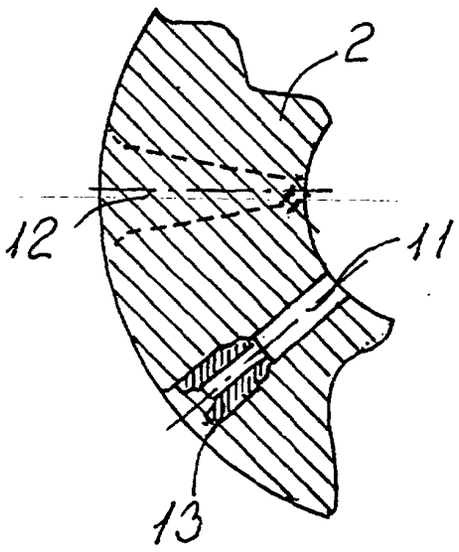


Fig. 2

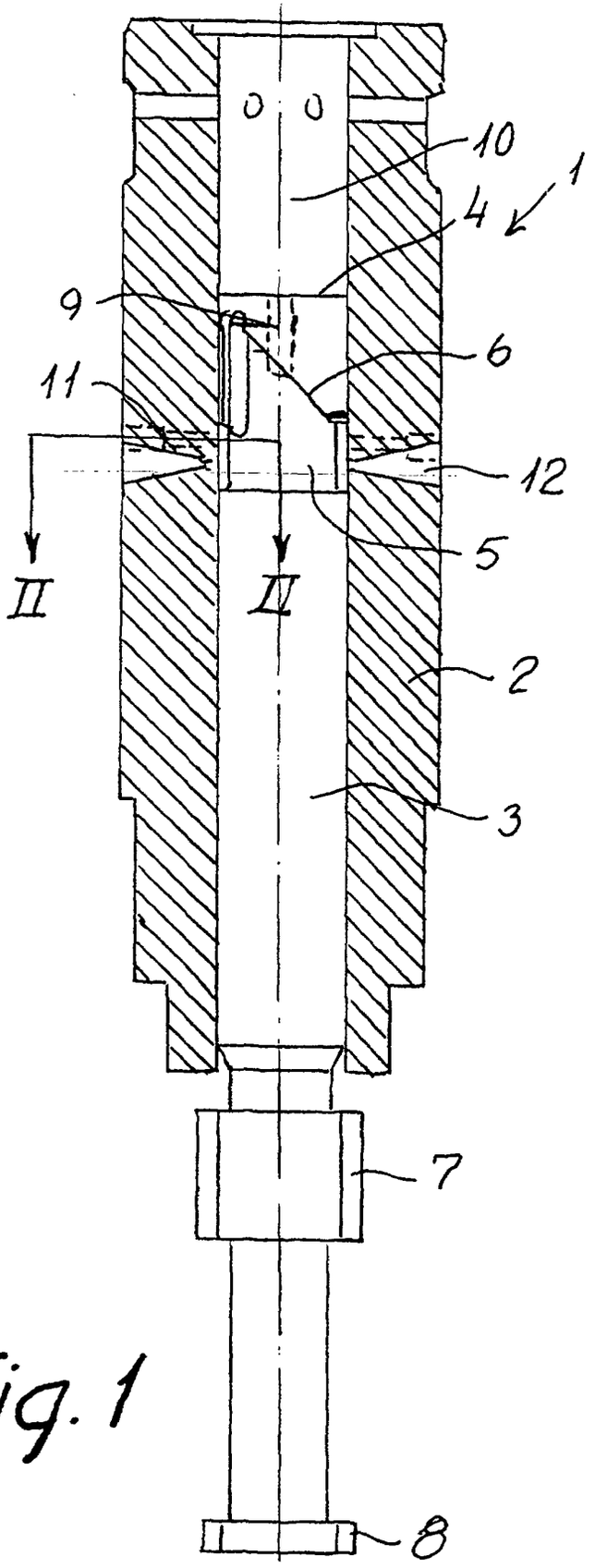
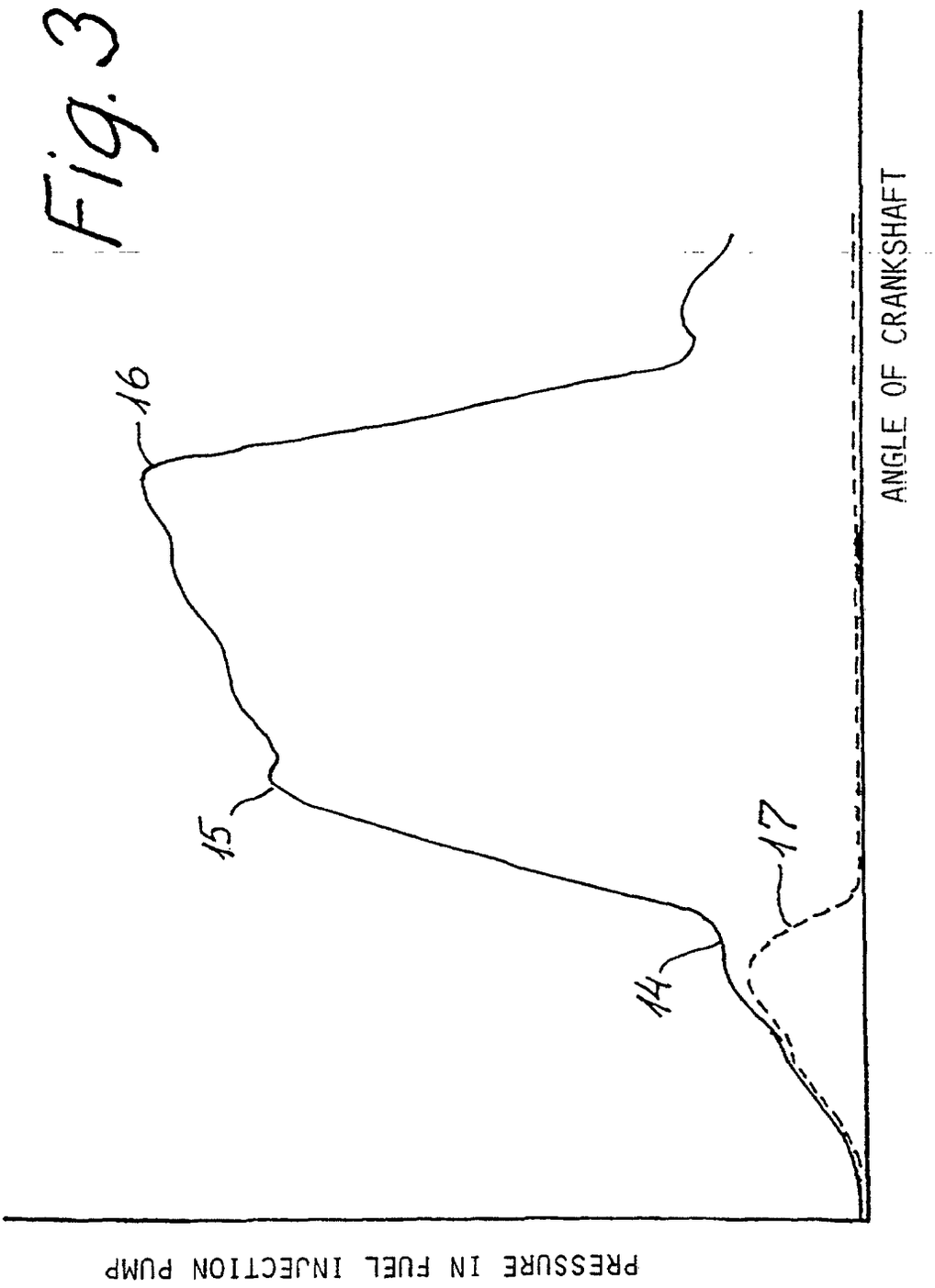


Fig. 1

Fig. 3


PRESSURE IN FUEL INJECTION PUMP
ANGLE OF CRANKSHAFT
14
15
16
17

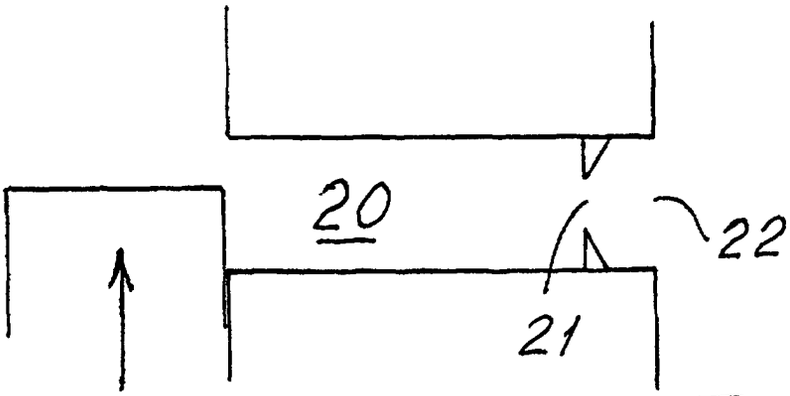


Fig. 4a

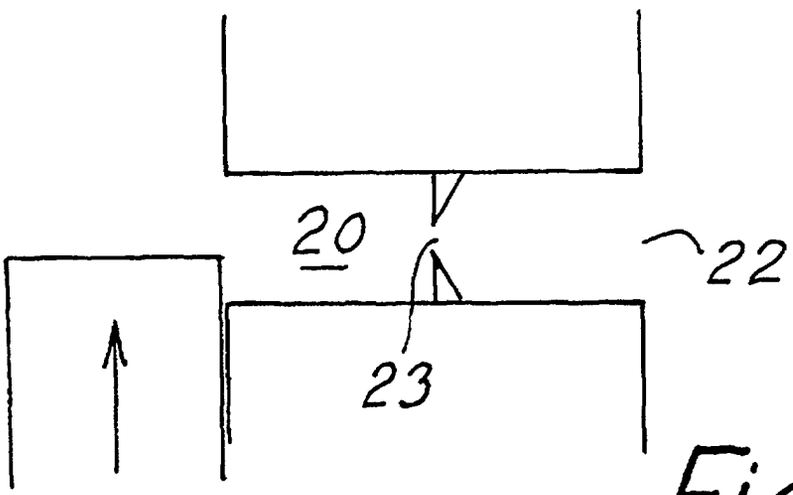


Fig. 4b

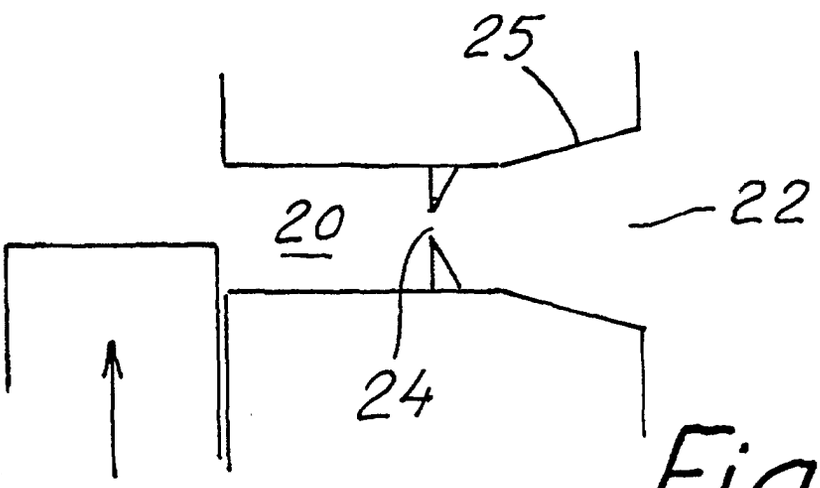


Fig. 4c