

[54] FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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[22] Filed: **Apr. 19, 1974**

[21] Appl. No.: **462,448**

Related U.S. Application Data

[63] Continuation of Ser. No. 289,642, Sept. 18, 1972,
abandoned.

[30] **Foreign Application Priority Data**

Sept. 18, 1971 Germany 2146797
Oct. 13, 1971 Germany 2150973

[52] U.S. Cl. **417/499**

[51] Int. Cl. **F04b 7/04; F04b 37/10**

[58] Field of Search 417/494, 499; 123/139 AB,
123/139 AA, 139 B

[57]

ABSTRACT

There is described a fuel injection pump which comprises at least one preassembled group of pump elements contained in a flanged sleeve that is fitted into a mounting bore of a pump housing and clamped thereto by a securing flange forming part of the flanged sleeve. The pump elements include a pump piston axially slidably and angularly adjustably disposed in a cylinder bore of the flanged sleeve. The pump elements also include a pressure valve, the stationary valve body of which is clamped inside the flanged sleeve by a threaded nipple engaging an internal thread provided in a terminal portion of said flanged sleeve. To relieve the flanged sleeve of the clamping stresses, particularly in the zone of the cylinder bore, the securing flange is permanently affixed to the flanged sleeve in the zone of said internal thread and axially spaced from said valve body.

[56] **References Cited****FOREIGN PATENTS OR APPLICATIONS**

269,560 3/1969 Austria 417/499

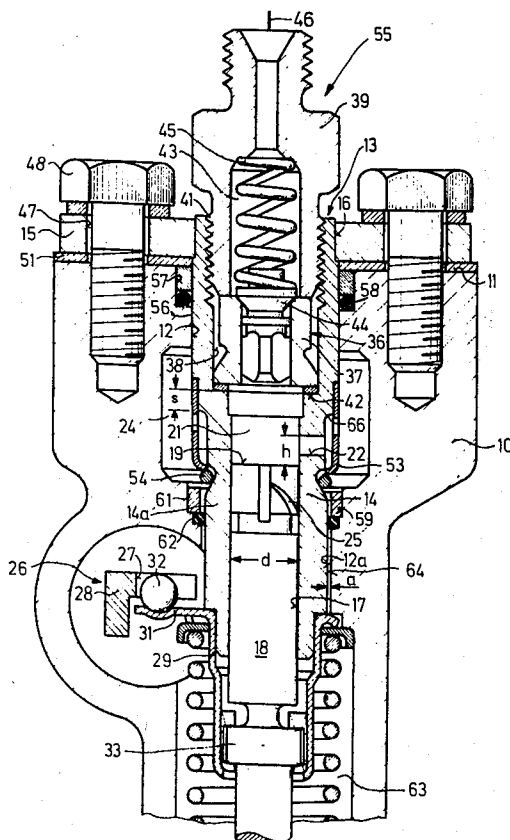
8 Claims, 2 Drawing Figures

Fig. 1

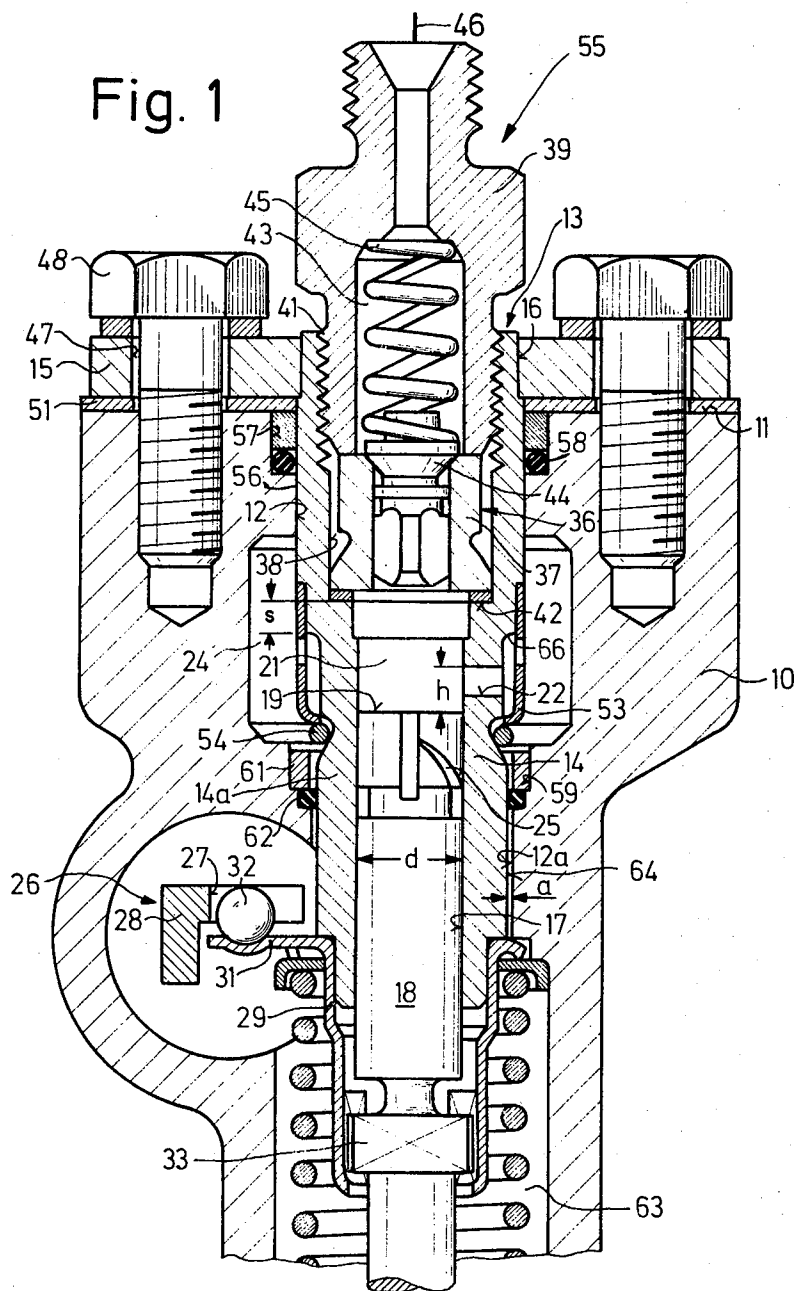
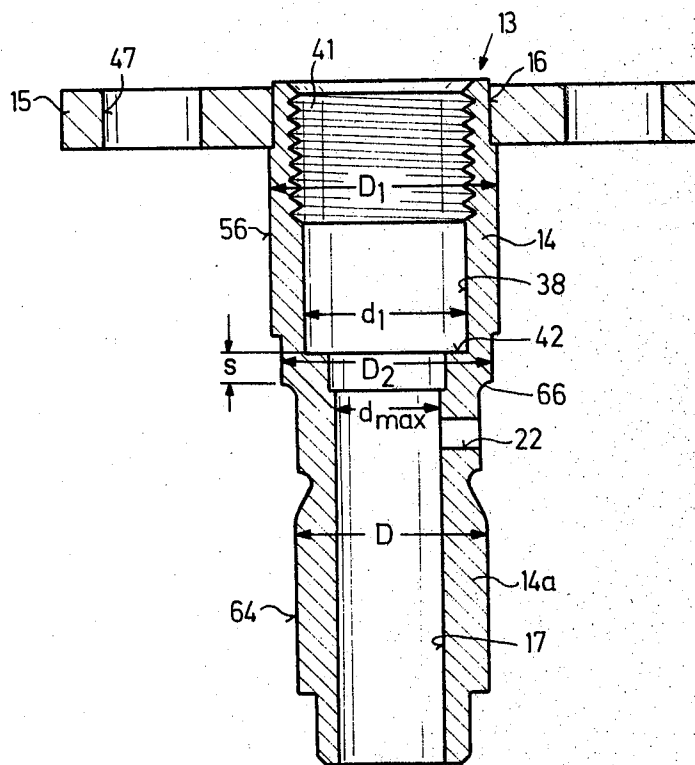


Fig. 2



FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

This is a continuation, of application Ser. No. 289,642, filed Sept. 18, 1972, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to a fuel injection pump for internal combustion engines and is of the type which has at least one preassembled group of pump elements inserted in a mounting bore of a pump housing made of light metal. Said group essentially comprises at least one pump piston which is provided with at least one oblique control edge and is rotatable for altering the delivered fuel quantities and a cylinder sleeve in which the pump piston is slidably guided. The pump piston cooperates with at least one control port which is provided in the wall of the cylinder sleeve and which communicates with the suction chamber of the pump. The cylinder sleeve is freely inserted into the mounting bore of the pump housing and is provided with an unremovable securing flange which is tightened to the upper edge face of the pump housing by means of bolts. A chamber which is a continuation of the cylinder bore receives a pressure valve, the valve body of which is tightened by means of a threaded nipple against a shoulder forming the transition between the cylinder bore and said chamber.

In known fuel injection pumps of the aforementioned type, such as disclosed, for example, in U.S. Pat. Nos. 3,004,496 and 3,046,896, the cylinder sleeves are formed as flanged sleeves and thus the pump housing is relieved of stresses derived from sealing forces. As a result, these pumps are particularly adapted for fuel injection at high injection pressures. In fuel injection pumps of this type, however, there is a danger that the stresses introduced by the tightened securing flange and the tightened pressure valve, both affecting the pump cylinder, leads to a deformation of the cylinder bore, causing jamming, wear or breakdown of the pump piston. In known pumps this danger is countered by designing the pump cylinder with sufficiently large dimensions. Such a solution, however, has the inherent disadvantage of large spatial requirements and significant material consumption in the manufacturing. In series pumps, for example, the large cylinder diameter leads to impermissibly large pump lengths.

OBJECT, SUMMARY AND ADVANTAGES OF THE INVENTION

It is an object of the invention to provide an improved fuel injection pump of the aforementioned type in which the afore-outlined disadvantages are eliminated and in which, while utilizing the smallest possible amount of material and structural space, the cylinder bore is not exposed to impermissibly high stresses. Thus, despite reduced material and spatial requirements, these pumps are particularly adapted for high pressure injection with pressures up to approximately 800 bars.

Briefly stated, according to the invention, the flanged sleeve is so designed that the securing flange is permanently attached to the cylinder sleeve exclusively in the zone of the internal thread receiving the threaded nipple and in the assembled state of the pump, the securing flange is situated axially spaced from the valve body clamped within the flanged sleeve.

The afore-outlined arrangement of the securing flange represents an optimal solution for the objects set forth hereinbefore and has been arrived at after exhaustive tests. This arrangement has the advantage that the outer diameter of the pump cylinder is determined only as a function of the sealing forces at the pressure valve and the hydraulic forces of the fuel delivered by the pump piston.

The invention will be better understood as well as further objects and advantages become more apparent from the ensuing detailed specification of a preferred, although exemplary embodiment taken in conjunction with the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal sectional view of the fuel injection pump according to the preferred embodiment of the invention, taken through the preassembled group of pump elements and

FIG. 2 is a longitudinal sectional view solely of the flanged sleeve of said group.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to FIG. 1, the only partially shown fuel injection pump illustrated therein has a pump housing 10 which is made of light metal and which carries, in a mounting bore 12, a flanged sleeve generally indicated at 13. The mounting bore 12 is disposed normal to the pump cam shaft (not shown) and extends into the pump housing 10 from an upper edge face 11. The flanged sleeve 13 comprises a cylinder sleeve 14 and a securing flange 15. The latter is inserted on an external cylindrical restriction 16 provided on the cylinder sleeve 14 and is permanently and rigidly connected therewith, for example, by hard soldering in a continuous furnace. The cylinder sleeve 14 is provided with a cylinder bore 17 which has an inner diameter d and in which there is slidably guided a pump piston 18. That part of the cylinder bore 17 which is bounded by the radial terminal face 19 of the pump piston 18 constitutes a pump work chamber 21. In the zone of the latter the wall of the cylinder sleeve 14 is provided with a throughgoing control port 22 through which fuel is introduced from a suction chamber 24 of the pump housing 10 into the pump work chamber 21 during the suction strokes of the pump piston 18. The control port 22 also serves to discharge that fuel portion which by means of the cooperation between the control port 22 with an oblique control edge 25 on the pump piston 18 returns from the pump work chamber 21 into the suction chamber 24 at the end of the effective pressure stroke during the pressure stroke of the pump piston 18. The quantity of the returning fuel is dependent upon the position of the oblique control edge 25 with respect to the control port 22. This position is determined by the angular position of the pump piston 18 which, for the purpose of altering the delivered fuel quantity, is angularly displaceable in the cylinder bore 17 by means of a known setting device 26. The latter comprises a longitudinally displaceable fuel rack 28 having openings 27 and a control sleeve 29 which, on the one hand, has an actuator arm 31 to which there is affixed a ball 32 projecting into the opening 27 of the fuel rack 23 and, on the other hand, is coupled with a lug 33 of the pump piston 18 in such a manner that the pump piston 18, independently from its axial move-

ment, follows the rotary motion of the control sleeve 29 as commanded by the fuel rack 28.

That side of the pump work chamber 21 which is remote from the radial face 19 of the pump piston 18 is bounded by a pressure control valve 36, the valve body 37 of which is inserted in an enlarged chamber 38 of diameter d_1 (FIG. 2) separated from the cylinder bore 17 by an inner annular shoulder 42. The valve body 37 is clamped against the shoulder 42 and held high-pressure tight by means of an externally threaded nipple 39. The nipple 39 is screwed into an internal thread 41 provided in the outer terminal portion of the chamber 38. To the threaded nipple 39, which accommodates in a spring chamber 43 a valve spring 45 for biasing the movable valve member 44, there is coupled a pressure conduit 46 (only symbolically shown) which forwards the fuel in a known manner to a fuel injector (not shown).

The securing flange 15 is tightened by means of bolts 48 against the upper edge face 11 of the pump housing 10. The securing flange 15 is provided with arcuate slots 47 to permit turning of the flanged sleeve 13 with respect to the housing 10 after loosening of the bolts 48 for the purpose of effecting, in a known manner, the basic setting for the fuel quantities to be delivered.

In the aforementioned basic setting, the relative position of the control port 22 with respect to the oblique control edge 25 is adjusted in such a manner that for a predetermined position of the fuel rack 26 there is delivered a predetermined fuel quantity. In a multicylinder fuel injection pump each cylinder is set to the same fuel quantity, that is, there is a uniform basic setting.

In addition to the uniform basic setting of the fuel quantities delivered by the individual pump pistons, there is also required a so-called advance stroke setting, by means of which the starting moment of the injection is determined. The advance stroke h is the displacement of the terminal radial face 19 of the pump piston 18 from the beginning of the pressure stroke until the land of the pump piston closes the control port 22 at which moment the fuel delivery (that is, the effective pressure stroke) begins. The advance stroke h is set in such a manner that in case of a multicylinder pump it is of equal magnitude for each element 14, 18. This setting is effected by an adjusting disc 51 which is inserted between the upper edge face 11 of the pump housing 10 and the securing flange 15. These discs are available in thickness of 0.05 mm so that the dimension h can be set in a sufficiently accurate manner.

On the flange sleeve 13, or, more accurately, on a restriction of the cylinder sleeve 14 having an outer diameter D_2 (FIG. 2), there is inserted a baffle sleeve 53 which is maintained in position by means of a snap ring 54 and which serves to absorb the impact energy of the fuel jet which is emitted at the end of the fuel delivery with high energy through the control port 22. The outer diameter of the baffle sleeve 53 is smaller than the greatest diameter of the cylinder sleeve 14. This feature ensures that the flanged sleeve 13, together with the pump piston 18, the pressure valve 36, the threaded nipple 39 and the baffle ring 53 may be inserted freely into the mounting bore 12 of the pump housing 10 as a preassembled closed group 55 of pump elements.

The group 55, or more accurately, the associated cylinder sleeve 14 is fitted into the mounting bore 12 of the pump housing 10 only by means of a guide collar 56 which is an integral part of the cylinder sleeve 14

and the outer diameter of which is designated with D_1 in FIG. 2. The guide collar 56 adjoins the restriction 16 and stops short of the zone of the cylinder bore 17. Immediately adjacent the edge face 11 of the pump housing 10 the mounting bore 12 is enlarged into a relatively narrow annular chamber 57 in which there is inserted, with a radial bias, a packing ring 58 for sealing the mounting bore 12 and thus isolating the suction chamber 24 from the external environment.

A lower, second part 12a of the mounting bore 12 has a chamber 59 in which there is inserted an O-ring 62 which is axially immobilized by a force-fitted ring 61 and which is radially biased by an appropriate selection of its diameter. The O-ring 62 seals the suction chamber 24 from a tappet spring chamber 63 provided in the pump housing 10 as the continuation of the mounting bore 12, 12a and is pressed against the lateral surface 64 of a portion 14a which forms part of the cylinder sleeve 14 and which is at the driven side of the pump. The cylindrical surface 64 of the portion 14a, the outer diameter of which is designated in FIG. 2 with D , is spaced from the lower portion 12a of the mounting bore 12 at a distance a . Stated differently, the mounting bore portion 12a surrounds the cylinder sleeve portion 14a with a clearance a . The purpose of this clearance a is to prevent the generation of distorting stresses in the cylinder sleeve 14 during and subsequent to the insertion and securing of the preassembled group 55 of pump elements to the pump housing 10. Such distorting stresses are normally caused by manufacturing tolerances of the pump components and may lead to the jamming of the pump piston 18 in the cylinder bore 17.

The stressfree suspension of the preassembled group 55 of pump elements makes it possible to test the group 55 apart from the entire pump and, in case of a multicylinder injection pump, the groups 55 may be assorted according to the tolerances regarding their hydraulic behavior. This significantly facilitates the final testing of the entire pump and furthermore makes possible a substantially automated setting.

The securing flange 15 which is soldered to the cylindrical outer face 16 exclusively in the zone of the internal thread 41, may be made advantageously of ordinary structural steel which remains soft and easily machinable even after the required heat treatment of the cylinder sleeve 14 which is made of a high-alloyed tempered steel. The securing flange 15 is axially spaced to such an extent from the cylinder bore 17 that the clamping stresses generated cannot cause any deformation in the zone of the cylinder bore 17. Also, the bending stresses generated by virtue of the protracted alternation of pressure strokes and suction strokes and emanating from the securing flange 15 and transmitted to the cylinder sleeve 14 lose their adverse effect. The last-named bending stresses are, to a major extent, already taken up by the upper part of the thread 41 which is adjacent the cylindrical outer face 16, since, as known, only the lower portion of the thread 41 transmits the stresses generated by the clamping of the valve body 37. It has thus been found that most advantageously the flange 15 is situated outside the zone of the valve body 37, that is, at an axial distance therefrom.

The preassembled group 55 of pump elements is adapted for high pressure injections with injection pressures of approximately 800 kg/cm², since the flanged sleeve 13 has, in the zone of the cylinder sleeve 14, a substantially homogeneous cross section along its en-

tire length, characterized by the dimensional relationships now to be set forth with particular reference to FIG. 2.

Between the annular shoulder 42 of the chamber 38 and the control bore 22 there extends an outer surface portion 66 which is rounded for the purpose of avoiding stress peaks. The portion 66 is situated from the shoulder 42 at an axial distance s that is at least $0.25 \times d_1$, which is the diameter of the chamber 38. From the portion 66 there extends towards the pump drive means a cylinder sleeve portion 14a forming part of the cylinder sleeve 14. The external diameter D of the portion 14a is at least 1.5 times greater than the diameter d_{max} of the largest possible cylinder bore 17. It is to be noted that in the production of fuel injection pumps it is quite customary to make, within one manufacturing series, pump pistons of different diameters according to the fuel quantities delivered, while the other pump components do not vary in dimension. The exception is the cylinder bore 17, the diameter d of which has to vary in accordance with the diametral dimension of the pump piston 18. The largest permissible fuel quantity is delivered at d_{max} , in which case the stresses also are the largest, so that the smallest possible external diameter of the flanged sleeve 13 has to be set according to d_{max} . The diameter d_1 of the chamber 38 is approximately $1.4 \times d_{max}$, because in case of a smaller diameter ratio of d_1/d_{max} the shoulder 42 would deform as a result of the clamping pressure of the pressure valve body 37. Above the surface portion 66 and in the zone of the guide collar 56 the outer diameters D_2 and D_1 of the cylinder sleeve 14 may be reduced down to $1.4 d_1$. This is only possible because the hardness of the cylinder sleeve 14, starting from the cylinder bore 17 which maintains a maximum material hardness of approximately 61 R, where R indicates Rockwell hardness decreases radially towards the surface portion 66 and axially towards the internal thread 41. Such a course of hardness is achieved by an inductive tempering, so that the cylinder sleeve 14, in the zone of the thread 41, is soft or has, for example, only a small residual hardness of approximately 35 R. The control bore 22 must have, similarly to the cylinder bore 17, the full hardness of, for example, 61 R in order to withstand the prevailing mechanical and hydraulic forces.

By combining the aforementioned features with the further features that the preassembled group 55 of pump elements is force-fitted into the mounting bore 12 directly underneath the securing flange 15 only by means of a guide collar 56 and that the lower portion 14a of the cylinder sleeve 14 is spaced with a clearance a from the lower portion 12a of the mounting bore 12, the group 55 is practically entirely free of clamping stresses. This permits the reduction of the outer diameter of the cylinder sleeve 14 (which diameter determines the spatial requirements of the pump) to such an extent that in case of a predetermined maximum diameter of the pump piston 18, the shortest possible pump length is achieved without adversely affecting the required maximum pump capacity.

This advantage may be fully exploited without adversely affecting the accuracy of the control of the fuel quantities, in case the aforementioned features are combined with the known setting device 26. The latter is, to a large extent, insensitive to the positional deviations which are possible by virtue of the clearance a and

which are caused by manufacturing tolerances in the group 55 and in the setting device 26.

What is claimed is:

1. In a fuel injection pump for an internal combustion engine, said pump being of the known type that includes
 - A. a one piece pump housing having
 1. an external edge face,
 2. a mounting bore extending into said housing from said edge face and defining a wall,
 3. a suction chamber,
 - B. a flanged sleeve formed of
 1. a cylinder sleeve having
 - a. a cylinder bore, said cylinder bore defining a wall,
 - b. an enlarged chamber adjoining said cylinder bore, said chamber defining a wall,
 - c. an inner annular shoulder separating said cylinder bore from said enlarged chamber,
 - d. an internal thread provided in the wall of said enlarged chamber and defining a zone of said wall of said enlarged chamber,
 - e. a throughgoing control port provided in the wall of said cylinder sleeve in a zone defined by said cylinder bore, said control port connecting said cylinder bore with said suction chamber and
 2. a securing flange fixedly attached to said cylinder sleeve and extending radially outwardly therefrom,
 - C. bolts for clamping said securing flange to said edge face,
 - D. a pump piston axially slidably and angularly adjustably disposed in said cylinder bore, said pump piston having on its lateral face an obliquely extending control edge cooperating with said control port during reciprocating motion of said pump piston,
 - E. means for adjusting the angular position of said pump piston for varying the position of said control edge with respect to said control port for altering the length of the effective pressure stroke of said pump piston during which fuel delivery takes place,
 - F. a pressure valve disposed in said enlarged chamber of said cylinder sleeve, said pressure valve having a stationary valve body, and
 - G. an externally threaded nipple engaging the internal thread of said enlarged chamber and clamping said valve body against said shoulder; said flanged sleeve, said pump piston, said pressure valve and said threaded nipple forming a preassembled group of pump elements, the improvement comprising:
 - i. a guide collar forming part of said cylinder sleeve and situated between said securing flange and said control port, said guide collar constituting the sole part of said preassembled group of pump elements that engages said mounting bore, the cylinder sleeve, apart from said guide collar, being disposed in said mounting bore with an annular clearance from the mounting bore wall;
 - ii. a longitudinally displaceable fuel rack; and
 - iii. an actuator arm secured to said pump piston and operatively connected to said fuel rack, said actuator arm and said fuel rack forming part of said means for adjusting the angular position of said pump piston, and wherein said cylinder sleeve is formed as a one piece member and said

securing flange is exclusively positioned in the zone defined by said internal thread and axially spaced from said valve body, wherein said cylinder sleeve has an external surface portion in the zone between said shoulder and said control port, the axial distance between the beginning of said external surface portion and said shoulder being at least 0.25 times the inner diameter of said enlarged chamber, said cylinder sleeve having a portion of reduced outer diameter extending from said external surface portion away from said enlarged chamber, said reduced outer diameter being approximately 1.5 times the inner diameter of the largest permissible cylinder bore, said cylinder sleeve having its maximum hardness in the zone of said cylinder bore, the hardness of said cylinder sleeve decreasing radially towards said external surface portion and axially towards said internal thread.

2. An improvement as defined in claim 1, wherein the hardness of said cylinder sleeve is approximately 61 R in the zone defined by said cylinder bore and at the most approximately 35 R in the zone defined by said internal thread.

3. An improvement as defined in claim 1, wherein any external diameter of said cylinder sleeve along that part thereof that extends from said external surface portion towards said securing flange is at least 1.4 times the inner diameter defined by said enlarged chamber, and wherein said last-named diameter is at least 1.4 times the inner diameter of the largest permissible cylinder bore.

4. An improvement as defined in claim 1, wherein said cylinder sleeve includes an outer cylindrical surface to which said securing flange is fixedly attached.

5. In a fuel injection pump for an internal combustion engine, said pump being of the known type that includes

A. a pump housing having

1. an external edge face,
2. a mounting bore extending into said housing from said edge face and defining a wall,
3. a suction chamber,

B. a flanged sleeve formed of

1. a cylinder sleeve having
 - a. a cylinder bore, said cylinder bore defining a wall,
 - b. an enlarged chamber adjoining said cylinder bore, said chamber defining a wall,
 - c. an inner annular shoulder separating said cylinder bore from said enlarged chamber,
 - d. an internal thread provided in the wall of said enlarged chamber and defining a zone of said wall of said enlarged chamber,
 - e. a throughgoing control port provided in the wall of said cylinder sleeve in a zone defined by said cylinder bore, said control port connecting said cylinder bore with said suction chamber and,

2. a securing flange fixedly attached to said cylinder sleeve and extending radially outwardly

therefrom,

C. bolts for clamping said securing flange to said edge face,

D. a pump piston axially slidably and angularly adjustably disposed in said cylinder bore, said pump piston having on its lateral face an obliquely extending control edge cooperating with said control port during reciprocating motion of said pump piston,

E. means for adjusting the angular position of said pump piston for varying the position of said control edge with respect to said control port for altering the length of the effective pressure stroke of said pump piston during which fuel delivery takes place,

F. a pressure valve disposed in said enlarged chamber of said cylinder sleeve, said pressure valve having a stationary valve body, and

G. an externally threaded nipple engaging the internal thread of said enlarged chamber and clamping said valve body against said shoulder; said flanged sleeve, said pump piston, said pressure valve and said threaded nipple forming a preassembled group of pump elements, the improvement wherein:

said securing flange is exclusively positioned in the zone defined by said internal thread and axially spaced from said valve body;

said cylinder sleeve has an external surface portion in a zone between said shoulder and said control port, with the axial distance between the beginning of said external surface portion and said shoulder being at least 0.25 times the inner diameter of said enlarged chamber;

said cylinder sleeve having a portion of reduced outer diameter extending from said external surface portion away from said enlarged chamber, said reduced outer diameter being approximately 1.5 times the inner diameter of the largest permissible cylinder bore; and

said cylinder sleeve has its maximum hardness in the zone defined by said cylinder bore, with the hardness of said cylinder sleeve decreasing radially towards said external surface portion and axially towards said internal thread.

6. An improvement as defined in claim 5, wherein the hardness of said cylinder sleeve is approximately 61 R in the zone defined by said cylinder bore and at the most approximately 35 R in the zone defined by said internal thread.

7. An improvement as defined in claim 5, wherein any external diameter of said cylinder sleeve along that part thereof that extends from said external surface portion towards said securing flange is at least 1.4 times the inner diameter defined by said enlarged chamber, and wherein said last-named diameter is at least 1.4 times the inner diameter of the largest permissible cylinder bore.

8. An improvement as defined in claim 5, wherein said cylinder sleeve includes an outer cylindrical surface to which said securing flange is fixedly attached.

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