

[54] SUPPORT AND GUIDE MEANS FOR THE FUEL RACK CONTAINED IN A FUEL INJECTION PUMP

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[22] Filed: Sept. 22, 1972

[21] Appl. No.: 291,181

[30] Foreign Application Priority Data

Oct. 2, 1971 Germany..... 2149362
July 22, 1972 Germany..... 2234197

[52] U.S. Cl. .... 417/499, 123/139 B

[51] Int. Cl. .... F04b 7/04, F04b 39/10

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

[56] References Cited

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Table with 4 columns: Patent No., Date, Country, and Reference No.
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[57] ABSTRACT

There is described a multicylinder fuel injection pump wherein the fuel rack which extends within the pump housing and in the length dimension thereof and which, when longitudinally shifted, alters the angular position of each pump piston in its cylinder for varying the effective pressure strokes, is supported along its entire length by a guide rail of U-shaped cross section held within the pump housing and extending along the entire length thereof.

17 Claims, 7 Drawing Figures

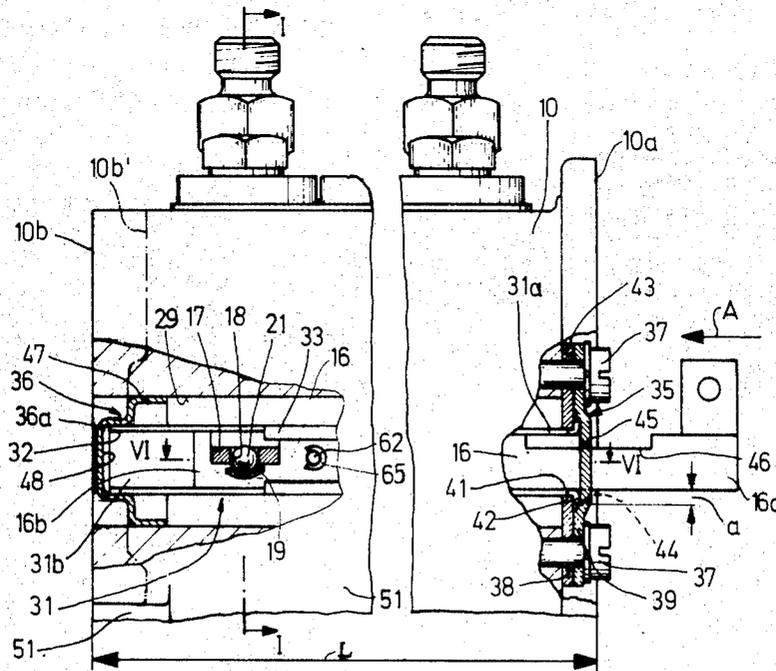
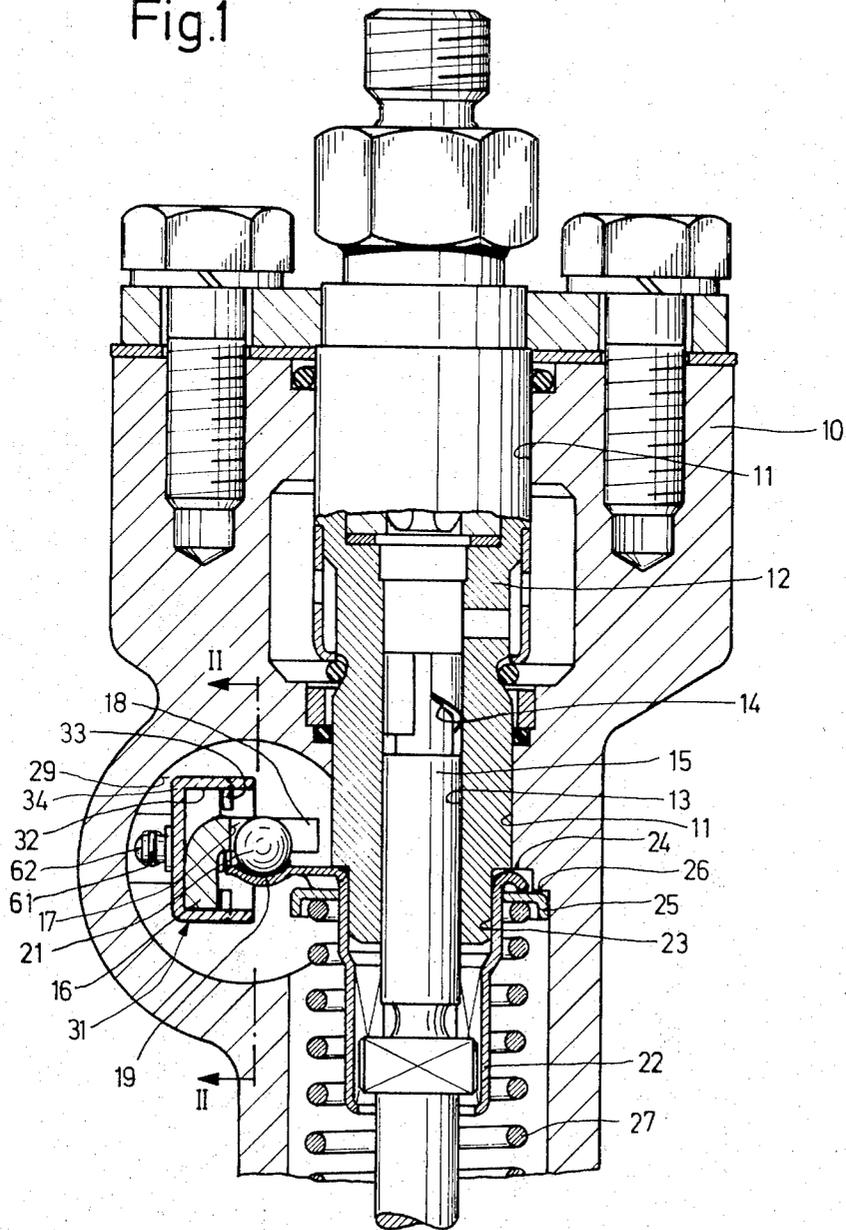


Fig.1



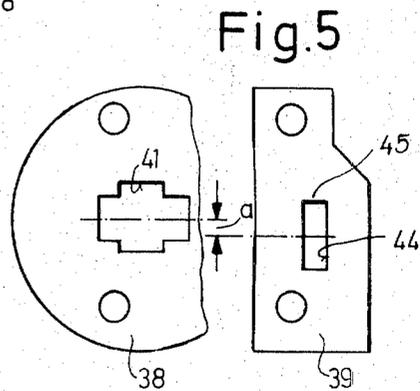
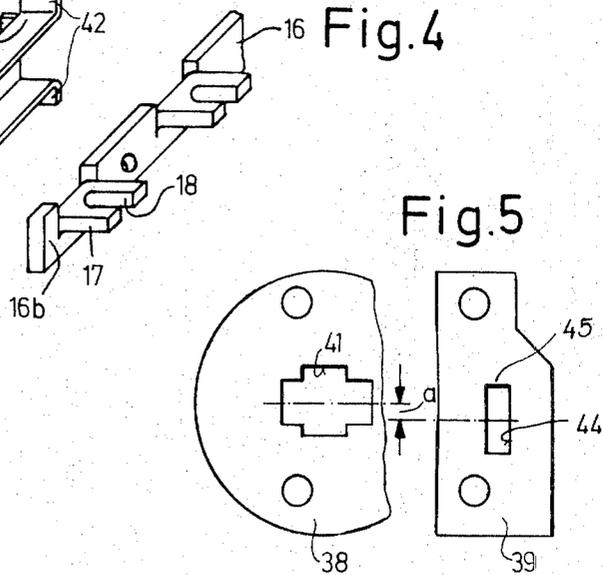
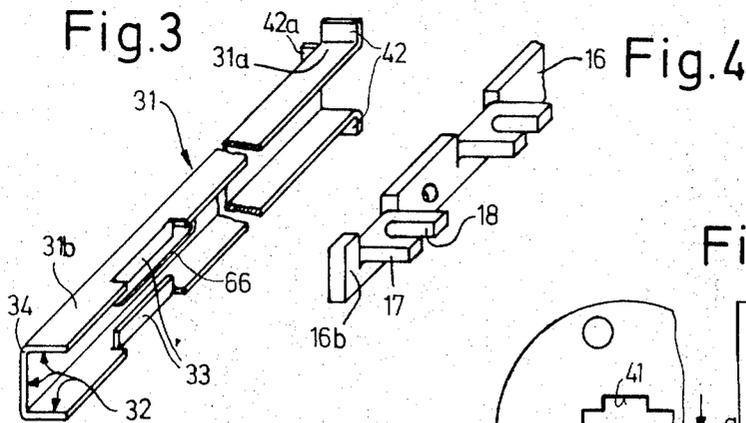
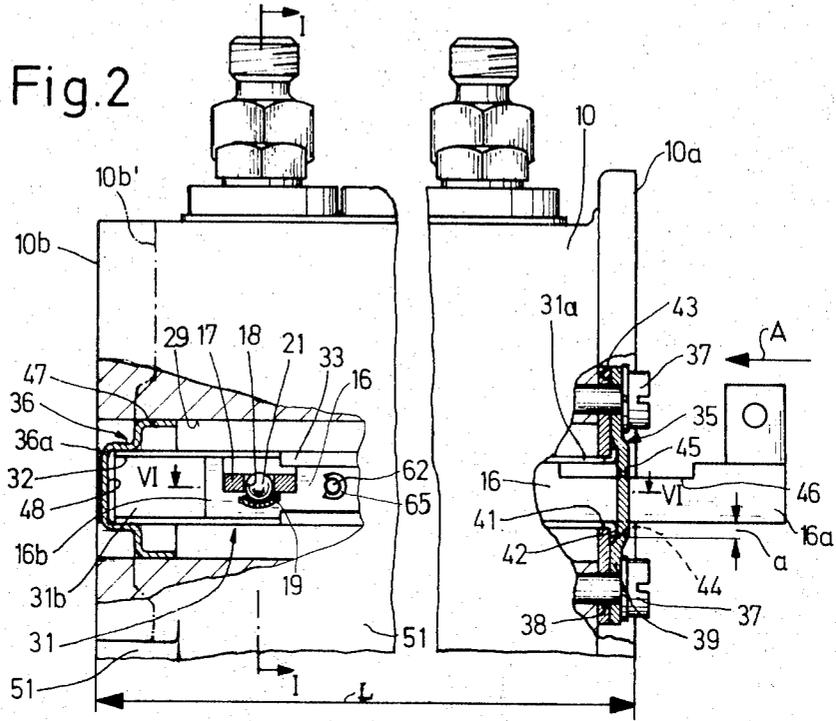


Fig. 6

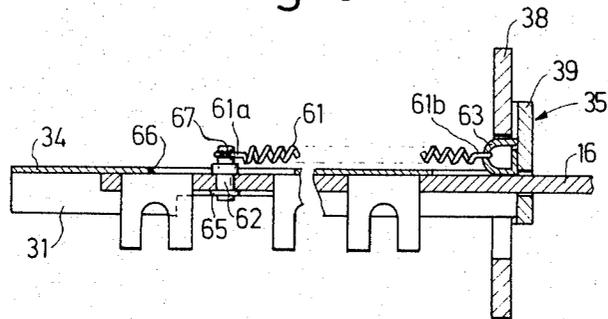
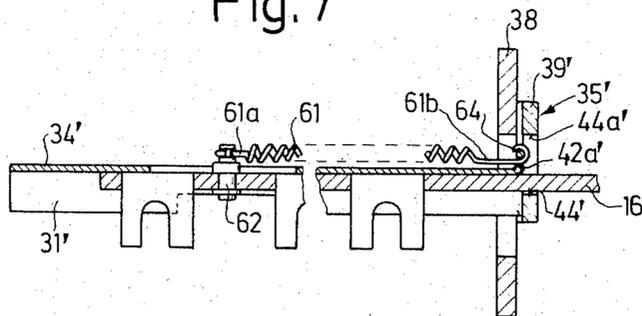


Fig. 7



## SUPPORT AND GUIDE MEANS FOR THE FUEL RACK CONTAINED IN A FUEL INJECTION PUMP

### BACKGROUND OF THE INVENTION

This invention relates to a fuel injection pump for internal combustion engines and is particularly concerned with a multicylinder serial pump which includes cylinder sleeves inserted into the pump housing and a pump piston reciprocating in each cylinder sleeve. Each pump piston is adapted to be angularly adjusted for varying the effective delivery stroke by means of a longitudinally shiftable fuel rack which is supported in the pump housing parallel to the longitudinal axis of the pump. The fuel rack projects outwardly from one side of the pump housing to be connected with a fuel quantity regulator.

In known fuel injection pumps of the aforeoutlined type (as disclosed, for example, in German Patent No. 1,138,982 and Austrian Patent No. 204,331), the fuel racks are supported in a bearing sleeve at the two end faces of the pump housing. The fuel rack is brought out of the pump housing at the end face adjacent the regulator and is covered by a closure cap at the end face which is adjacent the driving means for the pump. Such a bearing means for the fuel rack is, with respect to the length of the pump (particularly in case of pumps having a substantial number of cylinders) very short and is thus exposed to substantial wear. Furthermore, the fuel rack supported in the aforeoutlined known manner has to be sufficiently rigid so that a buckling thereof will not occur in case of rapid changes in the load. Such a design of the fuel rack, however, has the disadvantage that its weight is significant and thus, its inertia adversely affects the fuel regulation. In case of a small cross section of the fuel rack, on the other hand, at least one additional intermediate support has to be provided, the mounting of which, however, is difficult and in case of laterally closed pump housings, cannot be effected at all.

### OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved fuel injection pump in which the aforementioned disadvantages are eliminated, in which the support for the fuel rack is insensitive to wear and load and in which a simple mounting and an inexpensive mass manufacture of parts receive primary consideration.

Briefly stated, according to the invention, the fuel rack is supported in a guide rail which extends over the entire length of the pump housing and which has an inner wall configuration that is complementary to the cross-sectional outline of the fuel rack. The guide rail surrounds the fuel rack at least at three normally adjoining sides, while its side oriented towards the pump piston is open.

The provision of a guide rail according to the invention results in a support which is insensitive to wear and loads and which makes it possible to provide a fuel rack of extremely light weight.

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

### BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-sectional view on an enlarged scale

of the first embodiment of the invention taken along line I—I of FIG. 2;

FIG. 2 is a side elevational view of the first embodiment shown partially in section taken along line II—II of FIG. 1;

FIG. 3 is a perspective view of a guide rail according to the first embodiment;

FIG. 4 is a perspective view of a fuel rack used with the first embodiment;

FIG. 5 is a view of two further components in the direction of arrow A in FIG. 2;

FIG. 6 is a sectional view of a structural group taken along line VI—VI of FIG. 2; and

FIG. 7 is a view similar to FIG. 6 illustrating a structural group of a second embodiment of the invention.

### DESCRIPTION OF THE EMBODIMENTS

Turning now to FIGS. 1 and 2, in an only partially shown pump housing 10 of a multicylinder serial injection pump there are provided a plurality of parallel spaced mounting bores 11. In each there is inserted a cylinder sleeve 12, in the cylinder bore 13 of which there is disposed a slidable pump piston 15 provided with an oblique control edge 14. Each pump piston 15 is, in a known manner, angularly adjustable by means of a longitudinally shiftable fuel rack 16 for altering the effective delivery stroke. The terminus 16a of the fuel rack 16 projects outwardly from the end face 10a of the pump housing 10 to be connected in a known manner with a regulator, not shown. The other terminus 16b of the fuel rack 16 which is adjacent the pump drive means (not shown) is supported within the pump housing 10 and does not project, at any time, beyond the end face 10b of the pump housing 10.

The fuel rack 16 (see also FIG. 4) is a stamped sheet metal component which has a substantially rectangular cross section and from which, in the zone of the pump piston 15 there project, normal to the axis of the pump piston, bent coupling tabs 17, each having a slot-like opening 18 oriented toward the associated pump piston 15. Into the opening 18 there extends, as a force transmitting member, a sphere 21 which is soldered to a connecting arm 19 attached to the pump piston 15. The connecting arm 19 forms part of a regulator sleeve 22 which is rotatably guided on a lower bearing surface 23 of the cylinder sleeve 2 and which is axially immobilized between a shoulder 24 of the housing 10 and a spring seat disc 25.

The spring seat disc 25, which is supported by a shoulder 26 of the housing 10, is engaged by one end of a tappet spring 27 which, with its other end, engages a tappet in a known manner (not illustrated). The tappet, in turn, is driven by a cam shift in a known manner, also not illustrated, and, as a result, a reciprocating motion is imparted to the pump piston 15.

The fuel rack 16 is supported in a guide rail 31 (see also FIG. 3) which is inserted into a longitudinal bore 29 of the pump housing 10. The guide rail 31 extends over the entire length L of the pump housing 10 and has a U-shaped cross section 32. It surrounds the fuel rack 16 at three normally adjoining sides; the fourth side of the guide rail oriented towards the pump piston 15 is open with the exception of two inwardly bent guide flaps 33 which surround the terminus 16b of the fuel rack 16 in a jaw-like manner and thus prevent the fuel rack 16 from deflecting in the direction of the

pump piston 15. The guide flaps 33 are, as viewed from the driven side of the pump, disposed between the two first pump elements formed of the cylinder sleeve 12 and the pump piston 15. In case of very long fuel racks, several pairs of such flaps may be provided, or they may even extend over the entire length of the guide rail 31. The web or base of the U-shaped guide rail 31 is designated with 34. The guide rail 31 is maintained in its inserted position by two rail support guides 35 and 36 as seen in FIG. 2.

The first support guide 35 which is tightened against the end face 10a of the pump housing 10, or, more precisely, against a slightly recessed surface within said end face, by means of two bolts 37, is formed of two substantially identical support plates 38, 39 (see also FIG. 5). The first plate 38 has a throughgoing opening 41 which snugly surrounds one terminus 31a of the guide rail 31. The terminus 31a (see also FIG. 3) of the guide rail 31 has three rectangularly outwardly bent flange-shaped portions 42 and 42a which, for the purpose of axial immobilization of the guide rail 31, are tightened by means of the second support plate 39 against an outwardly projecting edge face 43 of the first support plate 38. The second support plate 39 has a throughgoing opening 44 which corresponds to the rectangular cross section of the fuel rack 16 and which is offset at such a distance *a* (see FIGS. 2 and 5) that a portion 45 of the plate 39 projects into a cutout 46 of the fuel rack 16 and serves as an abutment. During assembly, the second support plate 39 may be shifted by the distance *a* above the terminus 16a of the fuel rack 16. In the assembled condition the portion 45, as shown and as mentioned earlier, projects into the cutout 46 and serves as an abutment for limiting the maximum displacement of the fuel rack 16.

The second support guide (FIG. 2) is constituted by a deep drawn sheet metal cap 36 which is inserted with its cylindrical edge portion 47 in the zone of the end face 10b of the pump housing 10 and into the longitudinal bore 29 in a fluid tight manner. The second support guide 36 receives the terminus 31b of the guide rail 31 in a pocket-shaped depression 48 of rectangular configuration with such a clearance that the guide rail 31 may be inserted from the side of the end face 10a with ease and after assembly it is secured against rotation and held in its inserted position. The outermost end 36a of the sheet metal cap 36 does not project beyond the outermost axial portion of the pump housing 10. In the shown embodiment this outermost axial portion is the end face 10b with the mounting flange 51 which, as known, form a contiguous surface. The end face 10b of the housing 10, as illustrated with dash-dot lines 10b' in FIG. 2, may be set back with respect to the mounting flange 51; in this manner material may be saved in the manufacture.

When the pump is secured with its mounting flange 51 to the engine housing (not shown), the recessed sheet metal cap 36 is of substantial advantage, since it is not necessary to provide openings or depressions (which often have to be rendered fluid tight) for the fuel rack closure cap or to provide a longitudinally extended flange as it has been conventionally required.

The aforescribed short-length structure of the fuel rack guide means at the driven side of the pump is made possible only by means of the guide rail 31 in which, in contradistinction to the conventional bearing sleeves inserted into the end faces of the pump housing,

the terminus 16a of the fuel rack 16 has to be only of such a length that it is adapted to carry the actuating tab 17 associated with the first pump elements 12, 15 as seen from the driven side of the pump. Without the guide rail 31 (which along its entire length serves as a bearing), the fuel rack 16 should be extended to such a length that even in case of a maximum excursion towards the face 10a it does not slide out of its bearing at the driven side of the pump. If such a fuel rack is then moved in the opposite direction, it would necessarily project beyond the end face 10b of the pump housing 10.

As illustrated in FIG. 1 and shown in detail in FIG. 6, the structural group formed of the guide rail 31 of the fuel rack 16 and the first support guide 35 is provided with a play compensating spring 61. The latter is a tension spring having a small outer diameter and is, without requiring additional structural space, arranged within the longitudinal bore 29 of the pump housing 10 for operating parallel with the guide rail 31 and its web 34. The play compensating spring 61 serves to move the fuel rack 16 towards and maintain it in the arrested position, that is, in the present case, adjacent its terminus 16a with a slight spring force which does not affect the regulation. The play compensating spring 61 is suspended at two support points: one spring terminus 61a is hooked to a pin 62 affixed to the fuel rack 16 and its other terminus 61b is hooked to a component 63 affixed to the web 34 of the guide rail 31. As shown in FIG. 6, the part 63 is formed as a hook-like extension or sheet metal ear of the base 34 of the guide rail 31. In the second embodiment according to FIG. 7, on the other hand, the component connected with the web or base 34' of the guide rail 31' is formed as a flange-shaped extension 42a' provided with an opening 64 into which the spring terminus 61b may be hooked. The aforescribed arrangement results in an inexpensive, preassembled, easily insertable and removable structural group in which the tension spring 61 may be of soft structure. It is noted that play compensating springs which in conventional fuel rack guide means are arranged about that terminus of the fuel rack which is adjacent the regulator, cannot have an arbitrarily soft structure because of their given inner diameter. Furthermore, since these conventional springs are compression springs, they may buckle and then obstruct regulation.

The pin 62 connected with the fuel rack 16 by means of a snap ring 65 (see FIG. 6) extends through a slot 66 in the web 34 of the guide rail 31 and is provided with an annular groove 67 into which there is hooked the terminus 61a of the play compensating spring 61, so that the latter is disposed in the intermediate space between the wall of the longitudinal bore 29 of the housing 10 and the external side of the web 34 of the guide rail 31 without being in contact with either of these parts.

The fuel rack guiding means according to the invention has, when combined with the aforescribed regulating mechanism which is characterized essentially by the actuating arm 19 coupled to the pump piston 15, the additional advantage that it is largely insensitive to tolerances and clearances which in the mass production of these components is a particularly economical feature.

That which is claimed is:

1. In a support and guide means for a fuel rack contained in a multicylinder serial fuel injection pump being of known type that has (a) a pump housing having two end faces spaced at a distance that defines a length dimension of said pump housing, (b) a plurality of cylinder sleeves inserted in said pump housing along the length dimension thereof, (c) a pump piston positioned in each said cylinder sleeve, (d) a longitudinal bore provided in said pump housing for receiving said fuel rack (e) means connecting said fuel rack with each pump piston for altering its angular position in its cylinder sleeve upon longitudinal displacement of said fuel rack for changing effective delivery stroke of each pump piston, (f) a terminus forming a part of said fuel rack and projecting from one of said end faces of said pump housing, the improvement comprising,

A. a guide rail received in said longitudinal bore and extending along the entire length dimension of said pump housing, any cross section of said guide rail having an inner configuration complementary to the cross section of said fuel rack, said guide rail surrounding said fuel rack at three normally adjoining sides and being longitudinally open on its side oriented towards said pump pistons,

B. a first and a second rail support guide attached to said pump housing adjacent either end face thereof for maintaining said guide rail in an immobilized position, and

C. connecting arms, one coupled to each pump piston,

wherein said guide rail has a U-shaped section and said fuel rack, at least in the zone of said guide rail, has a substantially rectangular configuration,

wherein said guide rail has at least one pair of oppositely inwardly bent guide flaps extending at least partially across said open side oriented towards said pump pistons, and

wherein said fuel rack has angularly bent coupling tabs, one associated with each pump piston, each coupling tab having an opening into which extends a connecting arm, said coupling tabs and said connecting arms forming part of said means connecting said fuel rack with each pump piston.

2. An improvement as defined in claim 1, wherein said first rail support guide includes means for axially and radially immobilizing one end of said guide rail and said second rail support guide includes means for preventing the other end of said guide rail from rotational displacement.

3. An improvement as defined in claim 2, wherein said first rail support guide is formed of a first and a second support plate, said first support plate having an aperture closely surrounding one end portion of said guide rail, said last-named end portion projecting through said aperture and having outwardly bent flange-shaped portions clamped between said first and second support plates for an axial immobilization of said guide rail.

4. An improvement as defined in claim 3, wherein said second support plate has an aperture of a shape corresponding to the cross section of said fuel rack, said fuel rack extending through said last-named aperture and having a cutout portion along its zone cooperating with the last-named aperture, a portion of said second support plate bounding said last-named aperture projects into said cutout to constitute an abutment determining an extreme position of said fuel rack.

5. An improvement as defined in claim 2, wherein said second rail support guide is formed of a cap-like component having a cylindrical edge portion fitted fluid tight into said longitudinal bore adjacent one end face of said pump housing, said cap-like component further having a pocket-shaped depression receiving one terminus of said fuel rack and constituting said means for preventing rotational displacement thereof.

6. An improvement as defined in claim 1, wherein said fuel rack having another terminus remaining entirely within said guide rail in any operational position of said fuel rack; said second rail support guide and the adjacent end of said guide rail being inwardly recessed with respect to that end face of said pump housing that is remote from the one through which said fuel rack projects.

7. An improvement as defined in claim 1, including

A. a base forming part of said guide rail,

B. a longitudinally extending slot provided in said base,

C. a component affixed to said base,

D. a pin affixed to said fuel rack and projecting through said slot and

E. a play compensating tension spring having one end hooked to said pin and having another end hooked to said component, said tension spring extending within said longitudinal bore of said housing parallel to said guide rail.

8. An improvement as defined in claim 7, wherein said component is formed as an eyelet bent outwardly from said base in a hook-like manner.

9. An improvement as defined in claim 7, said guide rail having outwardly bent flange-shaped portions clamped in said first rail support guide, one of said flange-shaped portions constitutes said component, said last-named flange-shaped portion is provided with an opening into which one end of said tension spring is hooked.

10. An improvement as defined in claim 1, wherein said guide flaps are located at least in the zone of that terminus of said fuel rack that is remote from the terminus that projects outwardly from said pump housing.

11. In a support and guide means for a fuel rack contained in a multicylinder serial fuel injection pump being of known type that has (a) a pump housing having two end faces spaced at a distance that defines a length dimension of said pump housing, (b) a plurality of cylinder sleeves inserted in said pump housing along the length dimension thereof, (c) a pump piston positioned in each said cylinder sleeve, (d) a longitudinal bore provided in said pump housing for receiving said fuel rack (e) means connecting said fuel rack with each pump piston for altering its angular position in its cylinder sleeve upon longitudinal displacement of said fuel rack for changing effective delivery stroke of each pump piston, (f) a terminus forming a part of said fuel rack and projecting from one of said end faces of said pump housing, the improvement comprising,

A. a guide rail received in said longitudinal bore and extending along the entire length dimension of said pump housing, any cross section of said guide rail having an inner configuration complementary to the cross section of said fuel rack, said guide rail surrounding said fuel rack at three normally adjoining

sides and being longitudinally open on its side oriented towards said pump pistons and

B. a first and a second rail support guide attached to said pump housing adjacent either end face thereof for maintaining said guide rail in an immobilized position,

wherein said first rail support guide includes means for axially and radially immobilizing one end of said guide rail, said means being formed of a first and a second support plate, said first support plate having an aperture closely surrounding one end portion of said guide rail, said last-named end portion projecting through said aperture and having outwardly bent flange-shaped portions clamped between said first and second support plates for axial immobilization of said guide rail, and

wherein said second rail support guide includes means for preventing the other end of said guide rail from rotational displacement.

12. An improvement as defined in claim 11, wherein said second support plate has an aperture of a shape corresponding to the cross section of said fuel rack, said fuel rack extending through said last-named aperture and having a cutout portion along its zone cooperating with the last-named aperture, a portion of said second support plate bounding said last-named aperture projects into said cutout to constitute an abutment determining an extreme position of said fuel rack.

13. In a support and guide means for a fuel rack contained in a multicylinder serial fuel injection pump being of known type that has (a) a pump housing having two end faces spaced at a distance that defines a length dimension of said pump housing, (b) a plurality of cylinder sleeves inserted in said pump housing along the length dimension thereof, (c) a pump piston positioned in each said cylinder sleeve, (d) a longitudinal bore provided in said pump housing for receiving said fuel rack, (e) means connecting said fuel rack with each pump piston for altering its angular position in its cylinder sleeve upon longitudinal displacement of said fuel rack for changing effective delivery stroke of each pump piston, (f) a terminus forming a part of said fuel rack and projecting from said pump housing, the improvement comprising,

A. a guide rail received in said longitudinal bore and extending along the entire length dimension of said pump housing, any cross section of said guide rail having an inner configuration complementary to the cross section of said fuel rack, said guide rail surrounding said fuel rack at three normally adjoining sides and being longitudinally open on its side oriented towards said pump pistons and

B. a first and a second rail support guide attached to said pump housing adjacent either end face thereof for maintaining said guide rail in an immobilized position,

wherein said fuel rack has another terminus remaining entirely within said guide rail in any operational position of said fuel rack, and

wherein said second rail support guide and the adjacent end of said guide rail is inwardly receded with respect to that end face of said pump housing that is remote from the one through which said fuel rack projects.

14. In a support and guide means for a fuel rack contained in a multicylinder serial fuel injection pump being of known type that has (a) a pump housing hav-

ing two end faces spaced at a distance that defines a length dimension of said pump housing, (b) a plurality of cylinder sleeves inserted in said pump housing along the length dimension thereof, (c) a pump piston positioned in each said cylinder sleeve, (d) a longitudinal bore provided in said pump housing for receiving said fuel rack, (e) means connecting said fuel rack with each pump piston for altering its angular position in its cylinder sleeve upon longitudinal displacement of said fuel rack for changing effective delivery stroke of each pump piston, (f) a terminus forming a part of said fuel rack and projecting from said pump housing, the improvement comprising,

A. a guide rail received in said longitudinal bore and extending along the entire length dimension of said pump housing, any cross section of said guide rail having an inner configuration complementary to the cross section of said fuel rack, said guide rail surrounding said fuel rack at three normally adjoining sides and being longitudinally open on its side oriented towards said pump pistons and

B. a first and a second rail support guide attached to said pump housing adjacent either end face thereof for maintaining said guide rail in an immobilized position,

wherein said guide rail has a U-shaped section with at least one pair of oppositely inwardly bent guide flaps extending at least partially across said open side oriented toward said pump pistons, said guide flap being located at least in the zone of that terminus of said fuel rack that is remote from the terminus that projects outwardly from said pump housing, and wherein said fuel rack, at least in the zone of said guide rail, has a substantially rectangular configuration.

15. In a support and guide means for a fuel rack contained in a multicylinder serial fuel injection pump being of known type that has (a) a pump housing having two end faces spaced at a distance that defines a length dimension of said pump housing, (b) a plurality of cylinder sleeves inserted in said pump housing along the length dimension thereof, (c) a pump piston positioned in each said cylinder sleeve, (d) a longitudinal bore provided in said pump housing for receiving said fuel rack, (e) means connecting said fuel rack with each pump piston for altering its angular position in its cylinder sleeve upon longitudinal displacement of said fuel rack for changing effective delivery stroke of each pump position, (f) a terminus forming a part of said fuel rack and projecting from said pump housing, the improvement comprising,

A. a guide rail received in said longitudinal bore and extending along the entire length dimension of said pump housing, any cross section of said guide rail having an inner configuration complementary to the cross section of said fuel rack, said guide rail surrounding said fuel rack at three normally adjoining sides and being longitudinally open on its side oriented towards said pump pistons and

B. a first and a second rail support guide attached to said pump housing adjacent either end face thereof for maintaining said guide rail in an immobilized position,

wherein said guide rail has a U-shaped section including a base forming part of said guide rail, a longitudinally extending slot provided in said base, a component affixed to said base, a pin affixed to said

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fuel rack and projecting through said slot and a  
 play compensating tension spring having one end  
 hooked to said pin and having another end hooked  
 to said component, said tension spring extending  
 within said longitudinal bore of said housing paral-  
 lel to said guide rail, and  
 wherein said fuel rack, at least on the zone of said  
 guide rail, has a substantially rectangular configu-  
 ration.

16. An improvement as defined in claim 15, wherein 10

said component is formed of an eyelet bent outwardly  
 from said base in a hook-like manner.

17. An improvement as defined in claim 15, said  
 guide rail having outwardly bent flange-shaped por-  
 tions clamped in said first rail support guide, one of said  
 flange-shaped portions constitutes said component,  
 said last-named flange-shaped portion is provided with  
 an opening into which one end of said tension spring is  
 hooked.

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