United States Patent [19]

Pigeroulet et al.

[11] **3,871,344**

[45] **Mar. 18, 1975**

[54] **DEVICE FOR LIMITING THE DELIVERY PER REVOLUTION OF AN INJECTION PUMP**

[75] Inventors: **Jean Pigeroulet**, Villeurbanne; **André Brunel**, Oullins, both of France

[73] Assignee: **Societe Industrielle Generale de Mecanique Appliquee S.I.G.M.A.**, Venissieux, France

[22] Filed: **July 16, 1973**

[21] Appl. No.: **379,227**

[30] **Foreign Application Priority Data**

July 26, 1972 France 72.26891

[52] **U.S. Cl.** ..... **123/139 ST**, 123/179 L

[51] **Int. Cl.** **F02m 59/42**

[58] **Field of Search** .... 123/179 L, 139 ST, 139 AZ, 123/179 G, 140 MC

[56] **References Cited**

UNITED STATES PATENTS

2,619,080	11/1952	Weber	123/139 ST
3,311,102	3/1967	Voigt	123/179 L
3,640,259	2/1972	Garcea	123/179 L

FOREIGN PATENTS OR APPLICATIONS

501,250	4/1954	Canada	123/140 MK
740,674	11/1955	United Kingdom	123/139 ST
1,191,359	5/1970	United Kingdom	123/179 G

Primary Examiner—Charles J. Myhre
Assistant Examiner—William Rutledge, Jr.
Attorney, Agent, or Firm—Larson, Taylor & Hinds

[57] **ABSTRACT**

In the fuel injection pump there is provided an adjusting member for the delivery per revolution controlled by a regulator. This device comprises retractable stop means adapted to limit the stroke of the adjusting member, so that the delivery per revolution does not exceed a full load value. Control means for the retraction of said stop means are provided.

5 Claims, 5 Drawing Figures

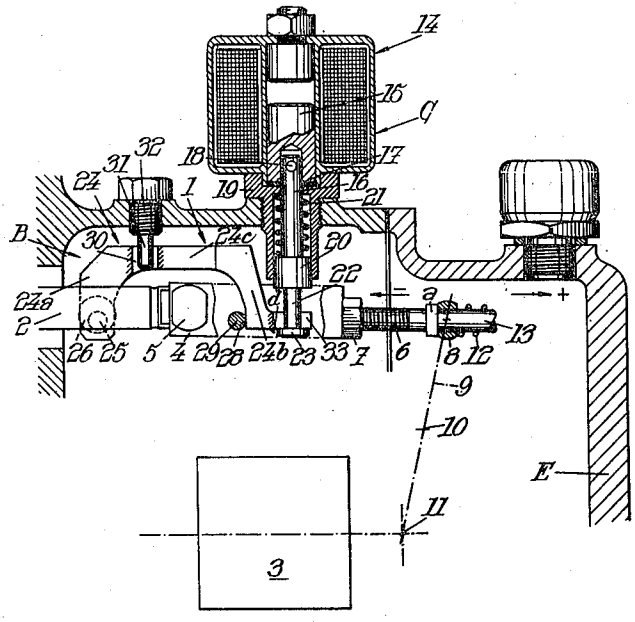


Fig. 1.

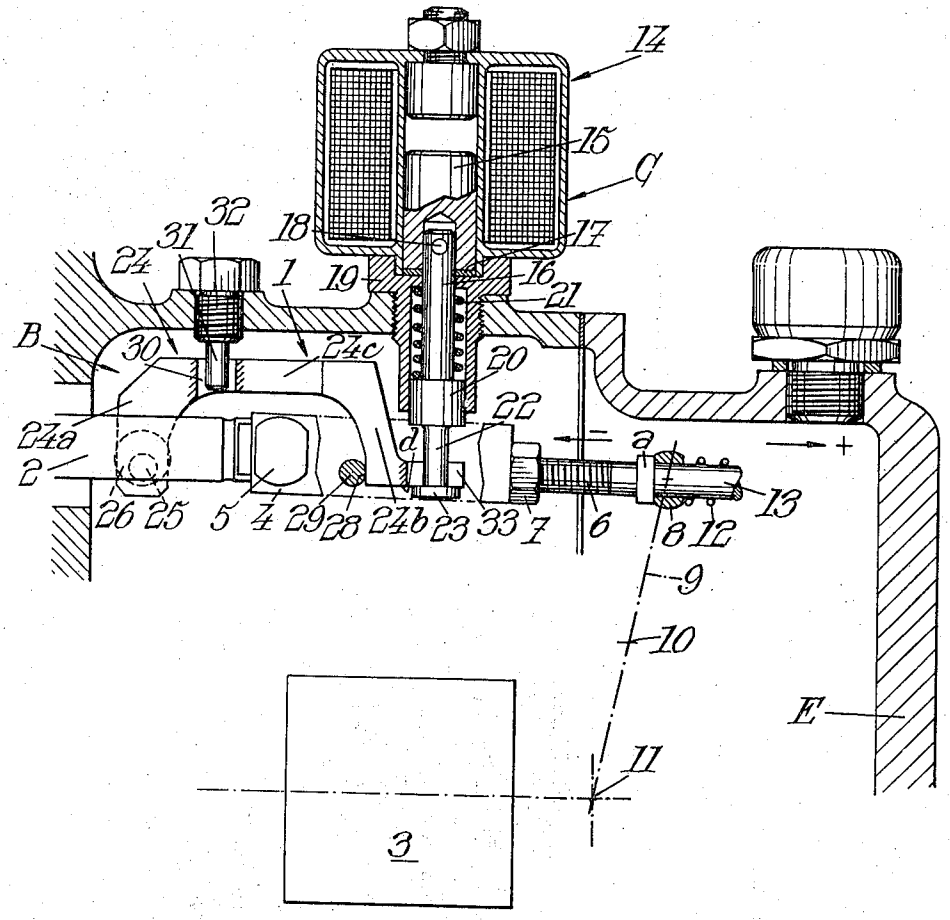

14
15
C
17
18
32
31
24
1
19
16
21
B
30
24c
20
22
24a
2
d
a
+
13
26
25
5
4
29
28
24b
23
33
7
6
8
12
9
10
E
11
3

Fig. 2.

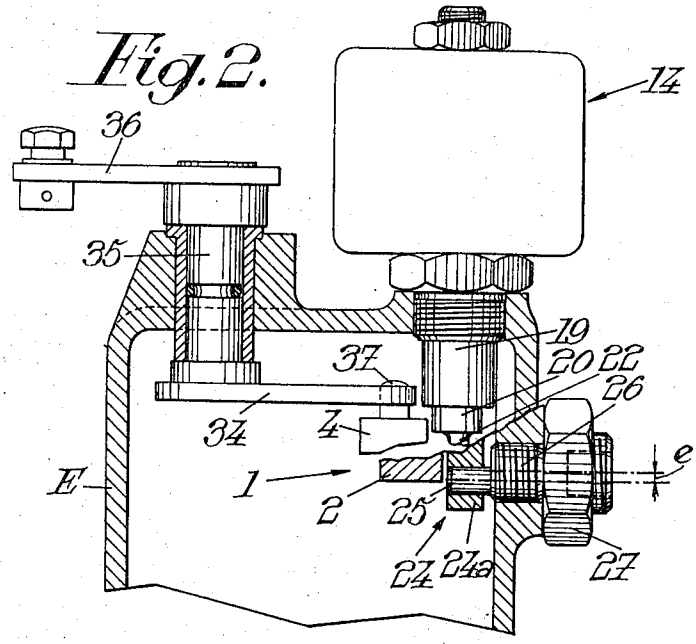
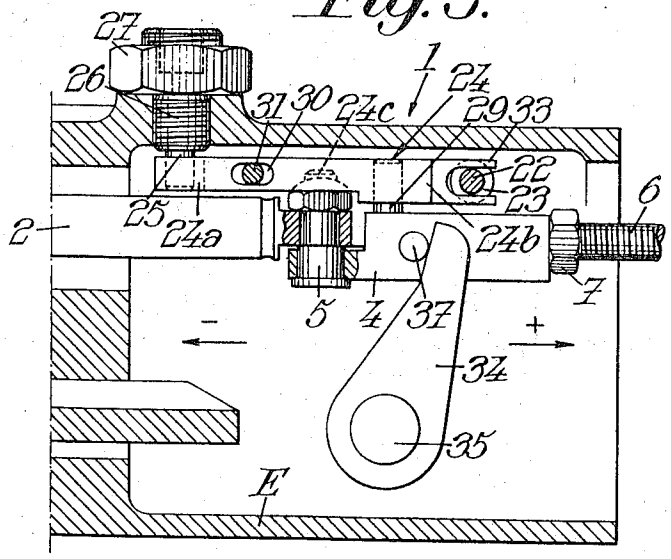

14
36
35
19
37
20
22
26
34
4
e
E
1
2
25
24
24a
27

Fig. 3.


27
26
1
24
31
30
24c
29
33
22
23
6
2
25
24a
24b
7
5
4
37
34
35
E
-
+

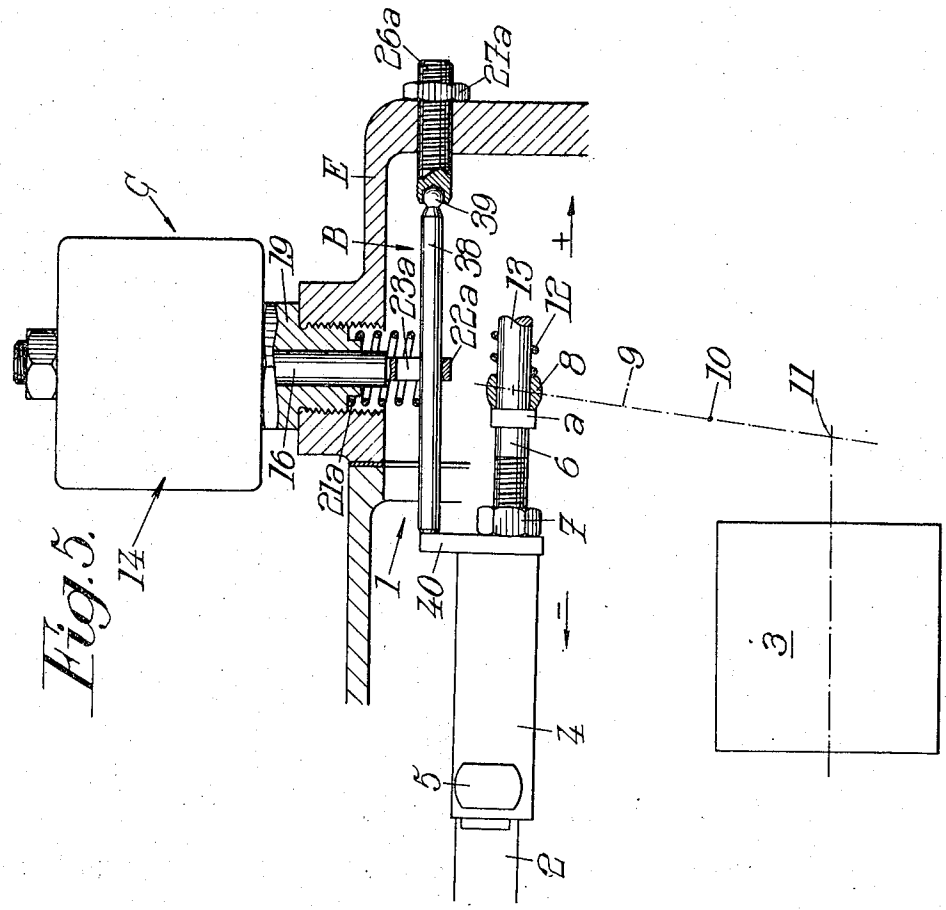

26a
27a
E
B
39
38
23a
22a
13
12
8
9
10
11
a
6
7
4
5
2
1
40
3
C
19
16
21a
14

Fig. 5.

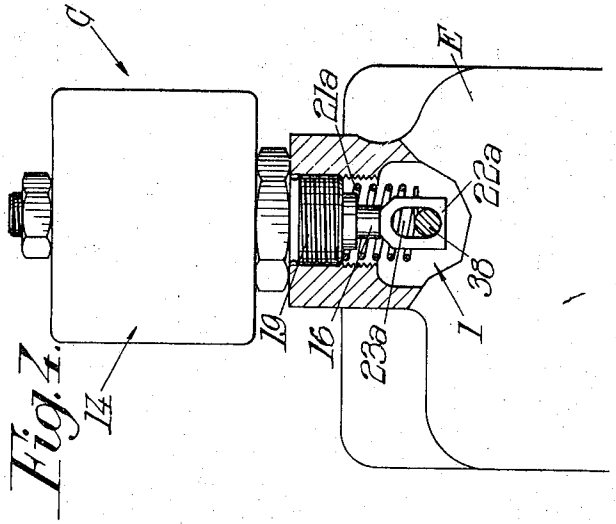

C
E
21a
22a
38
19
16
23a
1
14

Fig. 7.

DEVICE FOR LIMITING THE DELIVERY PER REVOLUTION OF AN INJECTION PUMP

The invention relates to a device intended to limit the delivery per revolution of a fuel injection pump for an internal combustion engine, in which pump there is provided a regulating member for the delivery per revolution controlled by a regulator which is driven by the engine supplied by the pump.

It is known that in such an injection pump, the delivery per revolution takes values essentially variable according to the conditions of operations of the engine. These various values of the delivery per revolution are adjusted by the regulator. Generally, on the starting of the engine, by an electric starter for example, it is necessary for the delivery per revolution to be high in order to facilitate the starting of the engine. This high flow rate on starting is denoted by the term "supercharge delivery."

On the other hand, when the internal combustion engine rotates on its own, the delivery per revolution of the pump is less than the supercharge delivery, the maximum value assigned to this delivery by the regulator being denoted by the term "full load delivery." This delivery corresponds to the optimal value enabling the creation of a maximum engine torque without the production of smoke due to unburnt fuel.

If, in the course of operation of the engine, the full load delivery is exceeded, an undesirable emission of smoke results. This can occur, especially, on sudden acceleration, the engine being previously at idling speed. The regulator then controls a rapid movement of the regulating member for the delivery per revolution of the pump and, by reason of the inertial forces which are applied to this regulating member, as well as to the moveable parts of the regulator, the value of the full load delivery can be exceeded.

It is a particular object of the invention to provide a device enabling the abovementioned drawbacks to be avoided or diminished.

According to the invention, a device intended for limiting the delivery per revolution of a fuel injection pump for an internal combustion engine, in which pump there is provided a regulating member for the delivery per revolution controlled by a regulator which is driven by the engine supplied by the pump, is characterised by the fact that it comprises, on one hand, retractable stop means adapted to limit the stroke of said regulating member so that the delivery per revolution does not exceed a full load value and, on the other hand, control means for the retraction of the abovesaid stop means adapted to come into action, especially on the starting of the engine, to enable the delivery per revolution to take values greater than those at full load.

Advantageously, the retraction control means are constituted by an electromagnet comprising a movable core adapted to cooperate, through a linking rod, with the retractable stop means.

The coming into action of the retraction control means may be servocoupled either to the operation of the electric starter, or to the temperature of a fluid of the engine which is heated on the operation of this engine, for example the cooling water or the lubricating oil of the engine.

When the regulating member for the delivery per revolution is constituted by a rack adapted to slide in its longitudinal direction, according to a first embodiment

of the invention, the retractable stop means comprise an arm which is curved at its two ends and of which the middle plane is parallel to the rack, which arm is pivoted on an axle perpendicular to its middle plane and comprises a concave portion adapted to cooperate in a zone spaced from the pivoting axle, with a finger borne by the rack and substantially perpendicular to the plane of the arm, the pivoting axle of said arm being borne by a casing shielding the injection pump.

This pivoting axle of the arm is advantageously mounted eccentrically on a screw, so that, by rotation of the latter, an adjustment may be effected, in the direction of the axis of the rack, of the position of the arm.

According to another advantageous embodiment of the invention, the retractable stop means comprise a rod, substantially parallel to the rack and pivoted, especially by a spherical ball-joint, on an adjusting screw borne by the casing and parallel to the rack; this rod traverses, preferably, an aperture provided in a plate borne by the connecting rod of the electro-magnet of the control means, said aperture being elongated in the direction of the axis of the rod; a transverse plate, connected to the rack, is provided to cooperate with the abovesaid rod when the latter is not retracted.

The invention consists, apart from the features explained above, of certain other features which will be more explicitly considered below with reference to a preferred embodiment of the invention which will now be described, in more detailed manner, with reference to the accompanying drawings, but which is in no way limiting.

FIG. **1** of these drawings is a view in elevation, with portions removed or cut away, of one embodiment of a device according to the invention.

FIG. **2** is a view from the right with respect to FIG. **1**, with portions removed or cut away.

FIG. **3** is a view from above, with respect to FIG. **1**, with portions removed and cut away.

FIG. **4** is a view from the right of another embodiment of the retractable stop means.

FIG. **5** lastly, shows, similarly to FIG. **1**, the retractable stop means of FIG. **4**.

Referring to FIG. **1**, there can be seen a device **1** for limiting the delivery per revolution of a fuel injection pump for an internal combustion engine. This injection pump comprises a regulating member **2** for the delivery per revolution, controlled by a regulator **3**, a centrifuge for example, shown diagrammatically, which regulator is driven by the engine supplied by the pump.

The regulating member **2** for the delivery per revolution is constituted by a rack adapted to slide in its longitudinal direction.

As seen in FIG. **3**, the rack **2** is coupled to a connecting part **4**, through a pivot **5** around which the said part **4** can rotate freely. The latter comprises a threaded axial hole opening on the opposite side to the rack **2** and in which is screwed a threaded rod **6**, parallel to the rack **2**. This rod **6** is blocked, in adjustable manner, on the part **4**, by a nut **7**.

As seen in FIG. **1**, the threaded rod **6** comprises a shoulder *a* adapted to become supported against a pivot **8** mounted at one end of a return lever **9**, as shown diagrammatically.

This lever **9** is pivoted at **10** in its middle portion, for example on the casing E shielding the injection pump, the device **1** and the regulator **3**. The other end **11** of

the lever 9 is connected to the regulator 3 so that the movements of said end 11 are controlled by said regulator. The shoulder *a* of the threaded rod 6 is held supported axially against the pivot 8 by a helical spring 12 arranged around a smooth extension 13 of the rod 6. The spring 12 is located on the side of the pivot 8 opposite the shoulder *a* and is compressed between this pivot and the end (not shown) of the extension 13.

A movement of the rack 2 from left to right of FIG. 1 causes an increase in the delivery per revolution, as shown by the arrow followed by the sign (+).

A movement in reverse direction causes a reduction in the delivery per revolution.

The device 1 comprise, on one hand, retractable stop means be adapted to limit the stroke of the rack 2 so that the delivery per revolution does not exceed a full load value and, on the other hand, control means C for the retraction of the stop means B.

The control means C are advantageously constituted by an electromagnet 14 of which the axle is at right angles to the rack 2. This electromagnet 14 comprises a core 15, movable along its axis and adapted to cooperate, by means of a linking rod 16, with stop means B. The shims 17 enable the stroke of the core 15 to be limited and hence that of the rod 16 connected to this core by a pin 18. The fixing of the armourture of the electromagnet 14 on the casing E is ensured by a bush 19 screwed into a threaded hole of said casing, this bush being coaxial with the rod 16. This rod comprises, towards its end distant from the core 15, a cylindrical portion of greater diameter forming a piston 20 serving as a stop for a helical spring 21 arranged between the piston 20 and the bottom of the bush 19 which is adjoining the core 15, the spring 21 serving as a return spring for said core. On the side of the piston 20 opposite the spring 21, the rod 16 is extended by a coaxial finger 22, of smaller diameter, of which the free end comprises a head or circular collar 23, having substantially the same diameter as the piston 20.

Preferably, the electromagnet 14 is arranged above the rack 2 and, if the latter is horizontal, the axle of the electromagnet 14 and the rod 16 are vertical.

When the electromagnet 14 is not energised, the core 15 is held in abutment against the shim 17, by the spring 21, as shown in FIG. 1. On the other hand, when the electromagnet 14 is energized, the core 15 passes into high position.

The retractable stop means B comprise an arm 24 curved at its two ends 24*a*, 24*b* substantially to a right angle. The shape of this arm 24 is clearly seen in FIG. 1 and the concave portion of the arm, in the shape of a U, is oriented downwardly. The middle plane of this arm is parallel to the axis of the rod 2 and to the axis of the electromagnet 14. Preferably, this plane is vertical as shown in the drawings.

The arm 24 is pivoted, at its end 24*a*, on an axle 25 perpendicular to the middle plane of the arm. As it is clearly seen in FIGS. 1 and 2, the axle 25 is mounted in eccentric manner on a screw 26, with a head having a blind hole, borne by the casing E and blocked on the latter by a counter-nut 27 (FIG. 2). The eccentricity between the axle 25 and the screw 26 is indicated by E in FIG. 2. By rotation of the screw 26, it is possible to adjust the position of the arm 24, in the direction of the axis of the rack 2. As seen in FIG. 3, the arm 24 is comprised, transversely, between the rack 2 and the neighbouring wall of the casing E.

The concave portion of the arm 24 comprises a zone 28 of which the surface, when this arm occupies the position shown in FIG. 1, is substantially vertical. The zone 28 is adapted to cooperate with the finger 29 borne by the intermediate part 4 and at right angles to the axis of the rack 2 and to the middle plane of the arm, as clearly seen in FIG. 3. The zone 28 constitutes the portion of the concavity of the arm which is distant from the axle 25.

The intermediate portion 24*c* of the arm 24 is parallel to the rod 2 and traversed vertically by a housing 30 of which the planar cross-section, as visible in FIG. 3, is elongated in the direction of the rack 2. This housing 30 is adapted to receive a guide pin 31 fixed coaxially to a screw 32 borne by the casing E. This pin 31 ensures the lateral guidance to the arm 24 and its maintenance in a vertical plane perpendicular to the axle 25.

The end 24*b* of the arm 24, spaced from the pivoting axle 25, comprises a fork 33 seen clearly in FIG. 3, extending the arm in the direction of the intermediate portion 24*c*. The extension 22 of the rod 16 is housed in this fork 33, which, through its lower flat surface *d* situated in the same plane as the lower surface of the end 24*b*, rests on the collar 23.

A stop lever 34, visible in FIGS. 2 and 3, is keyed on a rotary axle 35 of which an arm 36, accessible from the outside of the casing E, enables rotation in anti-clockwise direction, when looking at FIG. 3, to actuate the stopping of the engine by annulation of the delivery of the pump. This lever 34 cooperates with a pin 37 borne by the upper portion of the linking part 4.

The operation of the device of FIGS. 1 to 3 is as follows.

On starting, the electromagnet 14 is subjected to voltage, so that the core 15 passes from the low position shown in FIG. 1, to its high position. The piston 20 and the collar 23 are lifted; the arm 24, which is supported by the fork 33 on the collar 23, turns around the axle 25 in anti-clockwise direction, looking at FIG. 1. The stroke of the core 15 is adjusted in such a way that the rotation of the arm 24 is sufficient to free the finger 29 of the zone 28. The rack 2 can then be moved freely in the direction of increasing the delivery per revolution. Due to the fact that the engine is in the course of starting, the regulator 3 controls a displacement of the rack 2 until the position corresponding to the supercharge flow-rate, which is greater than the normal full load delivery rate. As a result the finger 29 is brought close to the finger 22 and it is passed below the end 24*b* of the arm 24.

Starting having terminated, and the internal combustion engine turning by itself, the electromagnet 14 is subjected to voltage, under the conditions specified below, so that the core 15 resumes its low position shown in FIG. 1. The collar 23 descends and the arm 24 turns around the axle 25, in clockwise direction, looking at FIG. 1, until the surface *d* comes to rest on the finger 29 which is moved when the regulator 3 has actuated the supercharge delivery. The arm 24 hence is supported, by gravity on the Finger 29.

When the rotary speed of the engine is sufficient, the regulator 3 will actuate the elimination of the supercharge, that is to say the movement of the rack 2 from right to left of FIG. 1.

When the rack is sufficiently moved in the direction of reduction of delivery, the finger 29 will be disengaged from the surface *d* of the end 24*b* of the arm 24,

so that the latter will be able to turn in clockwise direction around the axle **25.** The fork **33** will come to rest on the collar **23.**

Consequently, the movement of the rack **2** in the direction of increasing delivery will be limited to the value taken when the finger **29** comes into abutment against the zone **28** of the arm **24.** The adjustment is such that this value corresponds to the normal full load value.

Referring to FIGS. **4** and **5,** there can be seen another advantageous embodiment of the retractable stop means B. The identical elements were those already described previously are denoted by the same reference numerals.

The actuating means C are still constituted by an electromagnet **14** shown from the outside, only the lower end of the rod **16** appearing in FIGS. **4** and **5.**

The stop means B comprise a rod **38,** especially cylindrical, substantially parallel to the rack **2.** This rod **38** is pivoted, by a spherical ball joint **39** provided at the outside of the rod **38** spaced from the rack **2,** on an adjusting screw **26***a* screwed into the casing **6** and locked on the latter by the lock nut **27***a*. The screw **26***a* is parallel to the rack **2** and is mounted on the surface of the casing E towards which said rack is moved when an increase in delivery per revolution is actuated.

The rear portion of the connecting part **4,** turned towards the screw **26***a*, comprises a transverse plate **40** bounding the connecting part **4** towards the wall closest to the casing E and adapted to cooperate, as shown in FIG. **5,** with the end of the rod **38** when the latter is not retracted. It will be noted that the rod **38** is comprised, transversally, between the extension **13** and the neighbouring wall of the casing E.

The connecting rod **16** of the electromagnet **14** bears, at its end neighbouring the rod **38,** a plate **22***a* of which the middle plane is perpendicular to the axle of the rack **2.** This plate **22***a* comprises a window **23***a*, elongated in the direction of the axis of the rod **16** as seen in FIG. **4.** This window **23***a* is traversed by the rod **38.** The width of this window is equal to the diameter of the rod **38** so that the window **23***a* ensures the lateral guidance of said rod **38.** The elongated shape of this window enables angular movements of the rod **38,** the axis of the latter remaining in the plane passing through the axis of the rod **16** and parallel to the rack **2.** A return spring **21***a* is provided around the rod **16** and supported against the bush **19** and against the rod **38.** Whatever the inclination of the injection pump, this spring **21***a* ensures the operation of the retractable stop means. In fact, in the absence of energisation of the electromagnet **14,** the rod **38** is returned in position shown in FIG. **5** for which it limits the delivery per revolution of the pump to the full load value.

The operation of the device of FIGS. **4** and **5** is deduced immediately from that given for FIGS. **1** and **3,** so that it is unnecessary to dwell further on this subject.

It will be noted that the adjustment of the full load limiting value, which depends on the longitudinal position of the rod **38,** is ensured by the screw **26***a* which can be screwed or unscrewed in the casing E for the adjustment.

The placing under voltage of the electromagnet **14** can be servocoupled to the electric starter, so that when the starter is applied, the electromagnet **14** is under voltage.

In a modification, this placing under voltage can be servocoupled to a thermostat sensitive to the temperature of the cooling water or of the lubricating oil of the engine. When this temperature is below a predetermined limit, the thermostat controls the placing under voltage of the electromagnet, the removal of the voltage from said electromagnet being controlled by temperature values equal or greater than the predetermined limit.

The device according to the invention hence enables a mechanical limitation of the position of the rack of the injection pump at its full load value, without preventing, on starting the engine, this position being exceeded up to the over load value.

In normal operation, on sudden acceleration, the delivery injected will not exceed that of full load in spite of the inertial forces to which the rack and the movable parts of the regulator are subjected, and the production of smoke will be eliminated or reduced.

What we claim is:

1. In a fuel injection pump for an internal combustion engine, in which pump there is provided an adjusting rack member for adjusting the delivery per revolution, controlled by a regulator which is driven by the engine supplied by the pump, a device for limiting the delivery of the pump per revolution comprising: retractable stop means for selectively limiting the stroke of said adjusting rack member so that the delivery per revolution does not exceed a full load value, said retractable stop means comprising an articulated member pivotably movable between limiting and nonlimiting positions, said articulated member having two ends, one of these ends being pivotally mounted on an articulation, means for adjusting the position of said articulation along the direction of said rack member, said articulated member having a portion forming a stop abutment for the rack member when the articulated member is in its limiting position; automatic control means for the selective retraction of said stop means to the nonlimiting position on the starting of the engine, to enable the delivery per revolution to assume values greater than that of full load, said control means having an axis situated substantially in the plane of movement of the articulated member; said control means including a linking means between a movable element of said control means and a portion of said articulated member, said linking means allowing a limited degree of free angular movement of the articulated member relative to the movable element; and guiding means to keep the articulated member in a plane parallel to the axis of the control means and to the axis of the rack member.

2. Apparatus according to claim **1** in which the articulated member is an arm curved at its two ends, said arm being pivoted on an axle eccentrically mounted on a screw borne by the pump, the end of this arm which is removed from said axle comprising a zone forming an abutment for a finger borne by the rack member, said end of the arm being provided with a fork surrounding an extension of said linking means, said fork normally resting on a collar of said extension, the cooperation between the extension and the fork allowing said free angular movement of the arm relative to the movable element, said arm comprising an intermediate part parallel to the rack member, in which intermediate part a housing is provided for receiving a guide pin borne by the pump, said housing and pin forming said guiding means.

3. Apparatus as claimed in claim 1 in which the retractable stop means comprises a rod substantially parallel to the rack member and pivoted on an adjusting screw parallel to the rack member, said rod passing through a window provided in said linking means, said window having a shape elongated in the direction of the axis of the linking means for enabling angular movements of the rod relative to the linking means, the width of said window being equal to the diameter of the rod, said rack member having a transverse plate connected thereto for cooperating with said rod when the latter is not retracted, and a return spring for said linking means being supported on said rod.

4. Apparatus as claimed in claim 3 in which the rod is pivoted by a spherical ball joint.

5. Apparatus as claimed in claim 1 wherein the automatic control means are constituted by electromagnet comprising a movable core forming said movable element, and said linking means comprises a connecting rod.

* * * * *