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R. KLEEGERGER

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DEVICE FOR REGULATING THE DELIVERY OF FUEL INJECTION PUMPS

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FIG. 1

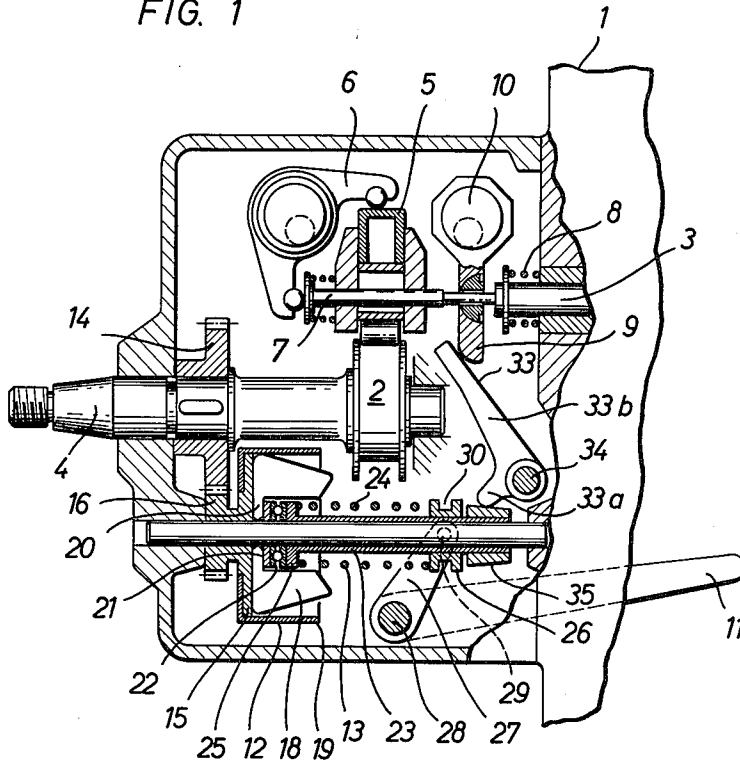


FIG. 2

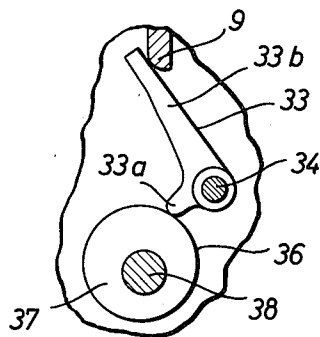
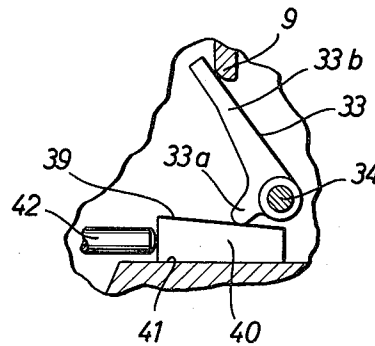


FIG. 3



Inventor
 Rudolf Kleeberger
 By *Stevens Davis Miller & Mosher*
 Attorneys

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DEVICE FOR REGULATING THE DELIVERY OF FUEL INJECTION PUMPS

Rudolf Kleeberger, Munich, Germany, assignor to Kugelfischer Georg Schafer & Co., Schweinfurt, Germany
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This invention relates to a device adapted to regulate the delivery of fuel injection pumps by varying the length of stroke of a pump plunger which is driven by a rotary cam. If the length of stroke of the pump plunger is short, the plunger, during its suction stroke, can only draw in a correspondingly small amount of fuel, which amount will be delivered by the pump during the subsequent delivery stroke; if the length of stroke of the pump plunger is greater, a correspondingly larger amount of fuel will be drawn in and delivered by the injection pump. In a fuel injection pump of the type in question, the length of stroke of the pump plunger is adapted to be varied by a rocker serving to limit the length of the suction stroke, the said rocker being adjustable, the arrangement being such that the initial position before each suction stroke and thus the length of stroke of the pump plunger can be varied. The regulation of fuel delivery by suitable variations in the position of the rocker limiting the length of the suction stroke of the pump plunger is effected by means of a control device provided either with a delivery rate adjusting member or with a speed selector lever, the said control device having the function of limiting the idling or the maximum speed of the associated internal combustion engine or to maintain constant, independently of the torque at any given moment, the speed that was preselected by means of the speed selector lever. The actuation of the fuel delivery adjusting member or the selection of the desired speed by means of the speed selector lever is effected in the conventional manner by the operator of the internal combustion engine. The said control device includes a speed transducer driven by the internal combustion engine, the output force of the said transducer effecting the required adjustment of the said rocker forming the abutment by which the length of the suction stroke is limited. The restoring force of the speed transducer is influenced by the position of the fuel delivery control member or that of the speed selector lever.

Upon completion of the suction stroke of the pump plunger, i.e. at the moment at which the plunger comes to abut the stroke limiting member, a very large force is exerted on the stroke limiting member, this force being partly produced by the plunger restoring spring and partly by the pump plunger which is being acted upon the pressurized fuel. These large forces acting on the stroke limiting member while the pump plunger abuts the limiting member also act upon the said control device and the speed transducer, thus causing a deflection of the speed transducer; this is then reflected in an undesirable change in the speed of the internal combustion engine. In order to obviate this drawback, it has been customary to use a speed transducer producing a very large output force in order to render the transducer as insensitive as possible to the restoring forces produced by the pump plunger. However, a speed transducer of this type is of considerable size and as a result of this it is necessary to provide a larger and correspondingly more expensive pump housing; moreover, even the use of a speed transducer of the type mentioned will not completely eliminate the said reaction of the pump plunger and the accompanying undesirable influence on the preselected speed of the engine.

According to the invention, in a device adapted to regulate the rate of fuel delivery of a fuel injection pump

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by varying the length of stroke of the pump plunger driven by a rotary cam, wherein the initial position of the pump plunger before each delivery stroke is determined by the angular position of a rocker forming an abutment serving to limit the length of the suction stroke of the plunger, there being associated with the injection pump a speed transducer whose output signal is a function of engine speed, the said drawbacks are eliminated by the provision, for the purpose of transmitting to the suction stroke limiting rocker the output force of the speed transducer, a two-armed bell crank lever having a longer arm abutting the free end of the pivotally mounted rocker, and having a shorter arm cooperating with a control member which is mechanically connected to the speed transducer, the arrangement being such that, while the pump plunger abuts the rocker, the said bell crank lever and control member cooperate in the manner of a locking mechanism. This arrangement is adapted to relieve the speed transducer of the restoring forces of the suction stroke limiting rocker transmitted therethrough from the plunger, the result being that it is possible to use a speed transducer adapted to produce a smaller output force, the speed transducer having correspondingly smaller dimensions.

According to another important feature of the invention, the speed transducer may be in the form of a spring-loaded centrifugal governor comprising a control sleeve adapted to be slidably displaced by centrifugal weights, the said control member being attached to or formed integrally with the control sleeve. The control member may also take the form of a rotary cam adapted to be moved angularly by the speed transducer by way of a suitable transmission arrangement. Furthermore, the control member may take the form of a sliding member which is provided with a control surface, and which is adapted to be displaced rectilinearly by the speed transducer by means of a suitable transmission arrangement.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawing, illustrating several preferred embodiments of the invention, wherein:

FIG. 1 is a fragmentary longitudinal sectional view of a fuel injection pump; and

FIGS. 2 and 3 are detail views showing two further embodiments of the control member.

The fuel injection pump 1 shown in FIG. 1 includes a pump plunger 3 adapted to be driven by a rotary cam 2. The rotary cam 2 formed on the pump drive shaft 4 drives the pump plunger 3 by way of a roller type tappet 5, a bell crank lever 6 and a second tappet 7, the plunger 3 being provided with a return spring 8.

The rate of fuel delivery of the injection pump is regulated by varying the stroke length of the plunger. For this purpose, there is provided, for cooperation with the plunger 3, a suction stroke limiting member in the form of a single-armed rocker 9, the angular position of the rocker 9 determining the starting position of plunger 3 before each individual delivery stroke. The angular position, at any given moment, of suction stroke limiting member 9 which is pivotally mounted on an eccentric 10 is determined by a control device whose function it is to maintain constant the speed of the associated internal combustion engine independently of the load imposed on the engine, the desired engine speed being preselected by means of a speed selector lever 11.

A complete description of the use and operation of member 9 is disclosed in applicant's copending U.S. application Serial No. 368,509, filed May 19, 1964.

The device of the invention includes a conventional speed transducer constituted, for example, by a centrifugal governor 12 provided with a restoring spring 13. For

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the purpose of driving the centrifugal governor, there is provided on the pump drive shaft 4 a gear wheel 14 meshing with another gear wheel 16 formed integrally with the housing 15 of the centrifugal governor. Supported by the shaft 17 of the centrifugal governor is the cup-shaped housing 15 of the governor in which there are suspended the centrifugal weights 18, the cylindrical skirt 19 of housing 15 forming an abutment serving to limit the outward deflection of the centrifugal weights. Each of the centrifugal weights 18 carries a lug 20 overlapping a thrust plate 21 which is freely rotatable on the governor shaft 17, the thrust plate 21 being supported by an antifriction thrust ball bearing 22 on that side of the bearing which is remote from a tubular governor sleeve 23 which is axially slidable along the governor shaft.

The restoring force required for the centrifugal weights 19 is provided by a coil spring 24, the end of spring 24 facing the centrifugal weights abutting a flange 25 of the control sleeve 23, the other end of spring 24 resting against an abutment 26 slidably carried by the control sleeve. For the purpose of varying the axial position of abutment 26, there is provided a lever 27 rigidly attached to a shaft 28 supported for rotation within the housing of the fuel injection pump, the lever 27 carrying a pin 29 engaging in an annular groove 30 extending along the periphery of abutment 26. The shaft 28 extends outwardly through the wall of the pump housing and carries on its external end a speed selector lever 11 which may be connected by a suitable linkage (not shown) to a hand- or foot-operated actuating lever provided at the operator's position.

For the purpose of transmitting the output signal of the centrifugal governor to the suction stroke limiting member 9, there is provided a bell crank lever 33 which is pivotally mounted on a pin 34 carried by the pump housing, the shorter arm 33a of the bell crank lever cooperating with a substantially frustoconical control member 35 carried by the control sleeve 24. It will be understood that it is also possible to provide a control sleeve one end of which is formed to constitute the control member. The longer arm 33b of bell crank lever 33 cooperates with the adjacent end of the stroke limiting member 9.

The bell crank lever 33, together with the control member 35 carried by the control sleeve 23 constitutes a locking mechanism which is adapted to lock the centrifugal governor in its respective position as long as the suction stroke limiting member is loaded by the pump plunger. Thus, it is only with the suction stroke limiting member being relieved of its load that the centrifugal governor can assume a different position, the output force of the governor in this case being required to overcome only its inherent mechanical resistance, the resistance of bell crank lever 33 and the resistance of the stroke limiting member 9. Therefore, it will be sufficient to provide a centrifugal governor producing a relatively small output force, such a governor having smaller dimensions than usual and thus requiring but little space in the pump housing.

FIG. 2 shows a modified embodiment in which the long arm 33b of the bell crank lever which is supported for rotation about the pivot 34 rests against the suction stroke limiting member 9, whilst the short arm 33a of the bell crank lever cooperates with a rotary cam constituting the control member 37. The control member or rotary cam 37 is rigid with a shaft 33 which is angularly positioned by a suitable speed transducer by way of a transmission arrangement.

FIG. 3 shows another modified embodiment in which the short arm 33a of the bell crank lever cooperates with a control surface 39 of a control member 40 taking the form of a sliding member. The sliding member 40 is supported for sliding rectilinear motion by guide tracks 41, the sliding member being adapted to be displaced by the speed transducer by way of a plunger 42 and a suitable

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transmission arrangement (not shown). Again, the bell crank lever, together with the rotary cam 37 of FIG. 2 or with the sliding member 40 of FIG. 3, respectively, forms a locking mechanism adapted to lock the speed transducer in its respective position as long as the suction stroke limiting member is loaded by the pump plunger 3, it being understood that the speed transducer, as shown in FIG. 1, takes the form of a centrifugal governor or an hydraulic or a magnetic speed transducer. It will be understood from the foregoing that, in similarity to the embodiment of FIG. 1, the speed transducer associated with the embodiment of FIG. 2 or of FIG. 3, respectively, can only assume a different position after the suction stroke limiting member has been relieved of its load.

The foregoing disclosure and drawings are merely illustrative of the principles of this invention and are not to be interpreted in a limiting sense. The only limitations are to be determined by the scope of the appended claims.

What is claimed is:

1. A device adapted to regulate the rate of fuel delivery of a fuel injection pump by varying the stroke length of a pump plunger which is adapted to be driven by a rotary cam, the starting position of the pump plunger before each delivery stroke being determined by the respective position of a rocker mounted on a pivot and constituting an abutment serving to limit the length of the suction stroke of the plunger, said pivot being adjustable independently of engine speed there being provided a speed transducer responsive to the speed of the associated internal combustion engine, wherein there is provided, for the purpose of transmitting the output force of the speed transducer to the suction stroke limiting rocker, a two-armed bell crank lever having a long arm resting against the free end of the pivotally mounted rocker, and having a short arm adapted to cooperate with a control member mechanically connected to the said speed transducer, the said bell crank lever and the said control member being adapted to act as a locking mechanism as long as the pump plunger abuts the said rocker.

2. The device of claim 1, wherein the said speed transducer is constituted by a spring-loaded centrifugal governor including a control sleeve adapted to be rectilinearly displaced by the centrifugal weights of the governor, the said control member being mounted on the said control sleeve.

3. The device of claim 2, wherein the said control member is integrally formed with the said control sleeve.

4. The device of claim 1, wherein the said control member has the form of a rotary cam adapted to be displaced angularly by the said speed transducer through the medium of a transmission arrangement.

5. The device of claim 1, wherein the said control member is constituted by a sliding member having formed thereon a control surface, the sliding member being adapted to be rectilinearly displaced by the said speed transducer through the medium of a transmission arrangement.

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RICHARD B. WILKINSON, *Primary Examiner*.