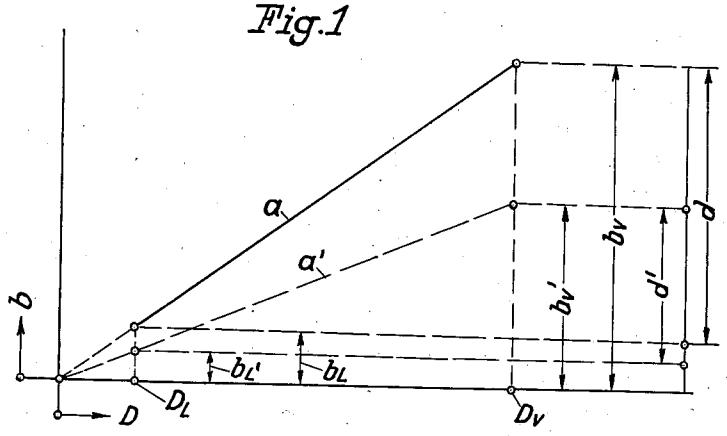
Nov. 4, 1941. F. NEUGEBAUER ET AL 2,261,856

FUEL PUMP CONTROL BY VARIABLE TRANSMISSION

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Fig. 1



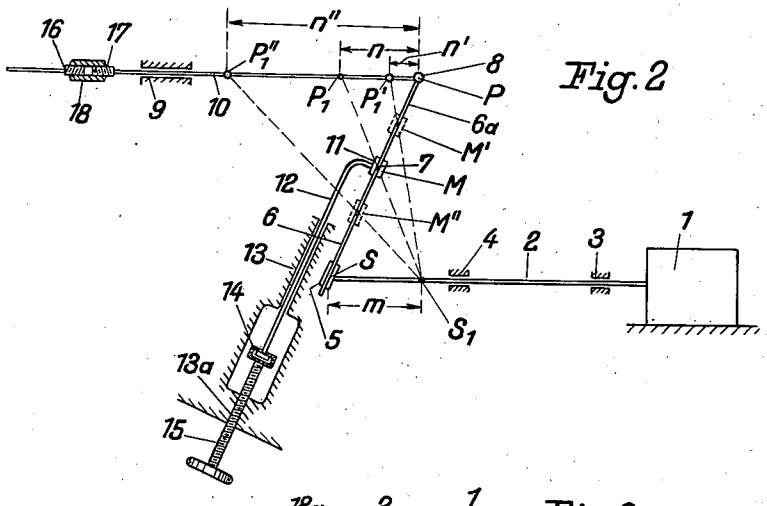


Fig. 2

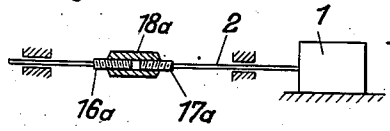


Fig. 2a

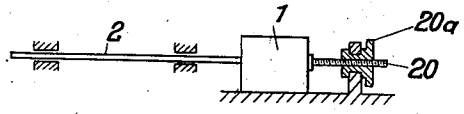


Fig. 2b

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FUEL PUMP CONTROL BY VARIABLE TRANSMISSION

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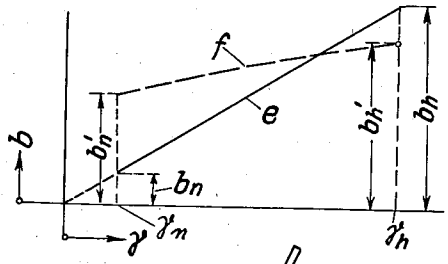


Fig.3

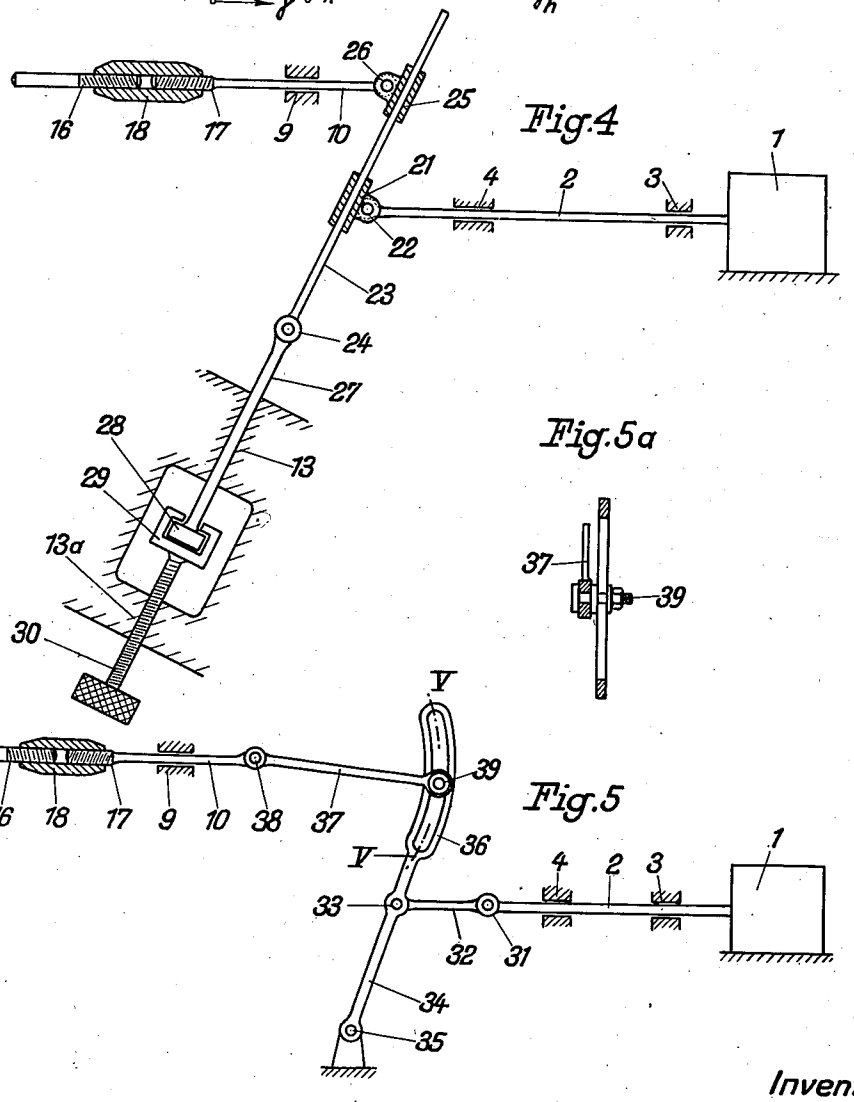


Fig.4

Fig.5a

Fig.5

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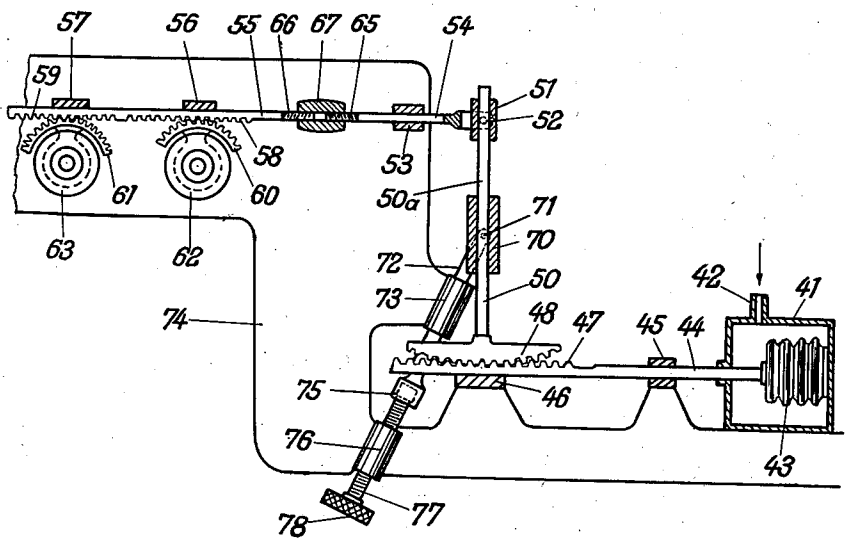
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Fig. 6



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FUEL PUMP CONTROL BY VARIABLE TRANSMISSION

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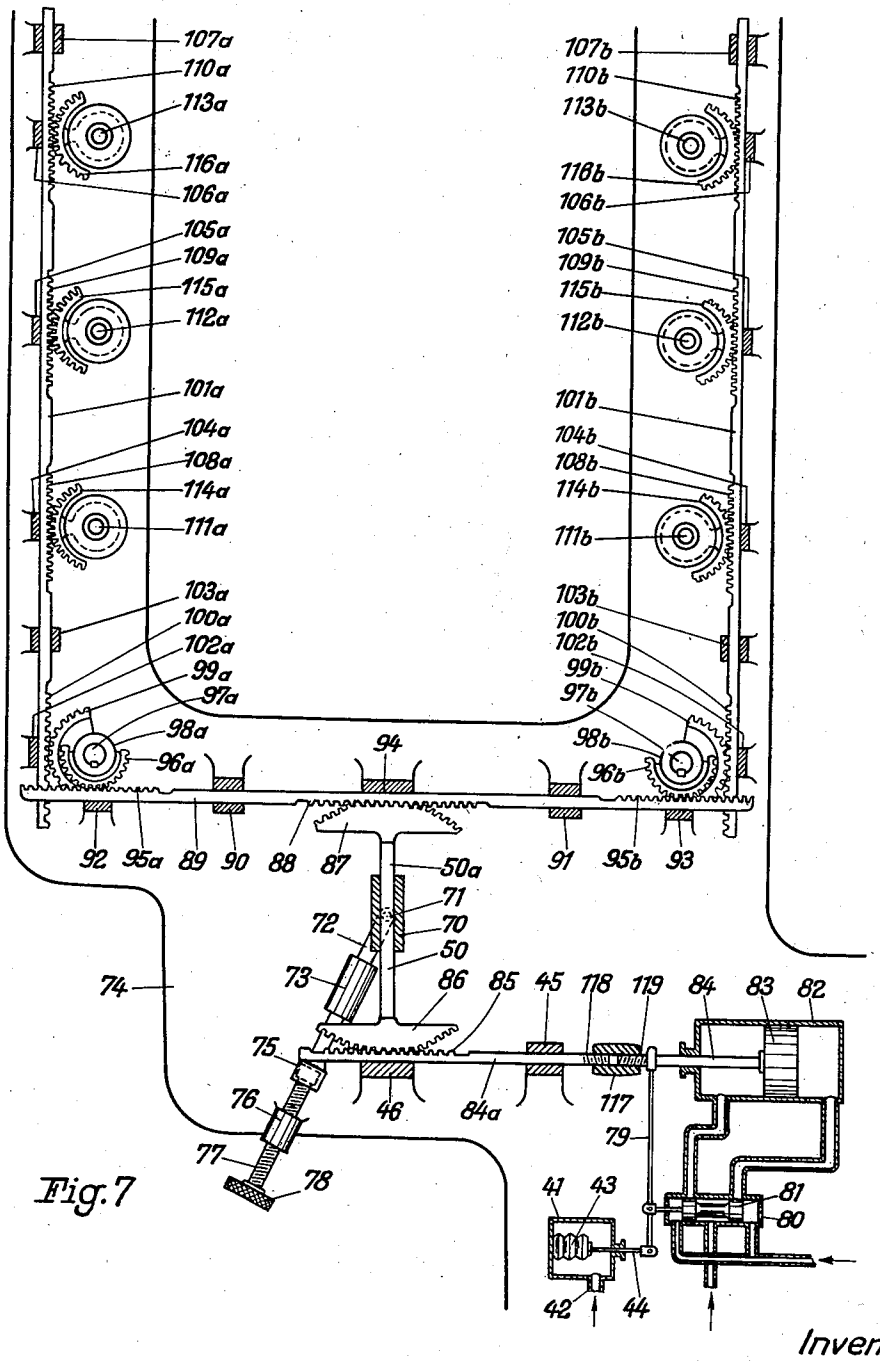


Fig. 7

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Patented Nov. 4, 1941 2,261,856

UNITED STATES PATENT OFFICE

2,261,856

FUEL PUMP CONTROL BY VARIABLE TRANSMISSION

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Application December 23, 1937, Serial No. 181,292
In Germany December 28, 1936

4 Claims. (Cl. 123—140)

This invention relates to fuel pumps and more particularly to fuel injection pumps of the kind used in connection with internal combustion engines of the fuel injection type.

It is an object of the present invention to provide injection pumps which may be used, in connection with a particular governor, with engines of different sizes, i. e. with engines having a larger or smaller stroke space per cylinder, wherein correspondingly a larger or smaller maximum amount of fuel per working stroke may be combusted.

It is a further object of the invention to provide fuel pumps of the type aforesaid, wherein the amount of the fuel delivery may be varied also with the position of the governor being unaltered.

It is a still further object of this invention to provide fuel pumps which, when used in connection with engines of the type where the density of the working cylinder charge may vary considerably, automatically adjust the fuel delivery to the charge density prevailing at each instant.

Other objects, and the manner in which the same are attained, will appear from the following description.

The present invention contemplates an arrangement for controlling the amount of delivery of fuel injection pumps of the kind used in connection with internal combustion engines of the injection type, which permits of adjusting pumps of particular sizes by means of a governor in a manner such that with a predetermined maximum throw of the governor the pump supplies larger or smaller maximum amounts of delivery. An arrangement of the type aforesaid renders it possible to use one and the same injection pump together with a particular governor with engines of different sizes, i. e. with engines having a larger or smaller stroke space per cylinder, wherein correspondingly a larger or smaller maximum amount of fuel per working stroke may be combusted. Thus the invention meets the problem of transmitting the throws of the governor to the adjusting member of the fuel injection pump so that with the throw of the governor remaining equal, this member is adjusted about a larger amount in one case, and about a smaller amount in another case.

In the drawings affixed to this specification and forming part thereof several embodiments of the invention are shown diagrammatically by way of example.

In the drawings:

Fig. 1 is a diagram indicating conditions in the case of a governor controlling the fuel pump delivery in dependency upon the degree of loading of the engine prevailing at each instant;

Fig. 2 illustrates one embodiment of the invention;

Figs. 2*a* and 2*b* show details of several modifications of the embodiment shown in Fig. 2;

Fig. 3 is a diagram indicating the adaptation of the pump delivery to the actual fuel consumption of an engine;

Figs. 4 and 5 illustrate several modifications of the invention;

Fig. 5*a* is a cross-section taken along line V—V of Fig. 5; while

Figs. 6 and 7 illustrate several adaptations of the invention for practical use.

Referring now to the drawings, and first to Fig. 1, this diagram illustrates conditions existing with a governor which controls the fuel pump delivery in dependency upon the degree of loading of the engine prevailing at each instant. The degrees of loading D are plotted on the abscissa, while on the ordinate there are plotted the quantities of fuel *b* to be supplied by the injection pump, which quantities must be combusted in the working cylinder per working stroke with the varying values of D. These quantities of delivery, proceeding from the value zero (at the degree of loading D=zero) increase with increasing degrees of loading. For the case of an engine cylinder having a particular stroke volume this dependency may be illustrated by the curve *a*. Herewith there corresponds, to the running light of the engine (degree of loading D_L) the amount of fuel b_L, while to full load (degree of loading D_V) there corresponds the amount of fuel b_V. For the case of a working cylinder having a smaller stroke volume the dependency, upon the degree of loading, of the amount of fuel per working stroke is illustrated by the curve *a'*. In this case the quantity of delivery b_L' corresponds to running light (D_L), while the amount of delivery b_V' corresponds to full load (D_V). Now, if in both cases the identical fuel pump and the identical governor shall be used, the power transmission system intermediate the governor and the pump adjusting member must be so provided, that with the working cylinder having the larger stroke volume, upon adjustment of the governor between the values D_L and D_V, the pump delivery is adjusted from b_L to b_V, i. e. about the amount *d*, whereas with the working cylinder having the smaller stroke volume, with

the identical throw of the governor, the pump delivery is varied only from b'_L to b'_V, i. e. about the smaller amount d'.

The present invention meets the problem discussed with reference to the diagram shown in Fig. 1, by inserting, in the transmission mechanism connecting the governor with the pump, a gearing member which is so provided that the control movements of the governor are transmitted to the delivery adjusting member of the pump to be adjusted by variable leverage, while, with an optionally adjusted leverage, to a predetermined position of the governor member there corresponds a constant position of the member adjusting the fuel delivery of the pump. Preferably the gearing member is provided in the form of a lever which may oscillate about a pivot, the governor and the pump rod applying on such lever in two further pivots, the lever being so provided that the position of one of these pivots may be varied with respect to the others.

In the embodiments of the invention shown in Fig. 2, a governor 1 is provided which responds to the variations of a physical factor occurring with variations of the degree of loading of an internal combustion engine intermediate running idle and full load, for example, to variations in the number of rotations, or to variations of the density of the air charge supplied to the working cylinders. The governor 1 is operatively connected with a rod 2 which is arranged displaceably along its longitudinal axis and is guided in the guides 3 and 4, a sleeve 5 being linked to the end of the rod 2. The sleeve 5 surrounds the free end of the one arm 6 of a double-armed lever 6, 6a which is arranged for pivotal movement about the joint 7. The end of the other arm 6a of this lever is connected, by means of a joint 8, with a rod 10, guided in the stationary guide 9 so as to be displaceable in the direction of its longitudinal axis, and connected with the adjusting member of the fuel injection pump (not shown). The pivot point of the lever is formed by the joint 7, which is arranged intermediate a sleeve 11 displaceably arranged on the lever 6, 6a, and a displaceable rod 12 guided in the stationary guide 13. This rod 12 may be adjusted by means of an adjusting screw 15 arranged screwably in the stationary nut 13a and connected with the rod 12 by a member 14 adapted to transmit longitudinal displacements only.

If, as shown in Fig. 2, with the joint 7 being positioned in the point M, the end of the governor rod 2 is located in a predetermined position, e. g. at S, also the position of the end of the rod 10 (point P) is predetermined. When the end of the governor rod is displaced about the distance m toward the position S_1, the double-armed lever 6, 6a is oscillated about its joint 7, whereby the end of the rod 10 is displaced from P to P_1 about the distance n. As shown in the drawing, the direction of displacement of the rod 12 and the joint 7 corresponds to the position of the lever determined by the points S and P. If now the joint 7, by adjustment of the adjusting screw 15, is displaced from the position M to the new position M' (closer to P), while indeed the leverage of this lever is altered, yet there corresponds, as before, to the governor position S the same position P of the pump adjusting rod 10. However, if now the governor is again brought into the position S_1, now the pump adjusting rod 10 is displaced about the smaller distance n' to the new position P'_1. Similarly, when the joint 7 is displaced to the position M'' (closer to S) there corresponds to the governor position S again the same position P of the pump adjusting rod 10; however, to the governor position S_1 now corresponds a position P''_1 of the rod 10 at the larger distance n'' from P. Thus the arrangement permits of obtaining, with the governor throw m remaining equal, varying displacements n, n', n'' of the rod 10 and thus also of the pump adjusting member.

With an arrangement of the type aforesaid, it is further desirable to vary the amount of delivery of the fuel injection pump also in the case where the position of the governor remains unaltered. For this purpose, as shown in Fig. 2, the pump adjusting rod 10 is divided in two parts. Of the adjacent ends of these parts, one is provided with a left hand screw thread 16, while the other carries a right hand screw thread 17, an adjusting nut 18 provided with corresponding screw threads being arranged on the screw threads 16 and 17 so as to bring these parts closer to, or further apart from, each other, whereby the length of the rod 10 is varied.

The arrangement 16, 17 and 18 provided on the rod 10 may be replaced, as shown in Fig. 2a, by a similar arrangement 16a, 17a and 18a provided on the governor rod 2. Furthermore, as shown in Fig. 2b, the governor may be arranged displaceably with respect to its support, for example, by means of an adjusting spindle 20 mounted on the governor 1 and a nut 20a which may be screwed on the spindle while being supported against displacement.

An arrangement of the type above referred to permits of so adapting, in a simple manner, the range of adjustment of the amount of delivery of a fuel pump to the fuel consumption of the engine, that the correct amount of fuel is supplied to the working cylinders with all conditions of operation between running light and full load. For this purpose at first the governor is brought into the position, where the longitudinal axis of the gearing lever 6, 6a coincides with the direction of displacement of the lever joint 7, i. e. where the pump always delivers the same predetermined amount of fuel, regardless of the leverage to which the lever is adjusted. Thereupon the nut 18, or 18a or 20a, respectively, is turned so as to adjust the pump to this particular amount of fuel delivery, for example, to a small amount which is just sufficient to keep engines of varying sizes running, or else to "no delivery"; thereafter the governor is brought into another position, corresponding e. g. to full load running of the engine, and now by turning the adjusting screw 15 the leverage of the lever 6, 6a is adjusted in a manner such that the resulting pump delivery is just adapted to that degree of loading of the engine to be supplied which corresponds to the last-named position of the governor.

An arrangement of the kind described may also be used in connection with an engine where the density of the working cylinder charge may vary to a considerable extent, for the purpose of adapting the fuel supply to be effected by a pump to the density of charge prevailing at each instant. The governors responsive to density and including a bellows-like governor member, which are here under consideration, when provided at corresponding measures, yet frequently display considerable deviations from the desired characteristic so that when they are directly structurally united with the pump they

frequently fulfil their task only incompletely or are even entirely useless.

The drawback above set out is eliminated by an arrangement according to the invention as will be explained with reference to the diagram shown in Fig. 3. In this diagram, the air densities γ are plotted on the abscissa, while the fuel deliveries per working stroke b are plotted on the ordinate. The line e indicates that fuel amount per working stroke, which may be brought to combustion in the engine in dependency upon the density of the air charge. Let us assume that with the highest occurring density γ_h this amount is b_h, with the lowest occurring density γ_n this amount is b_n. Let us further assume that any optional governor, when directly connected with the pump, yield an adjustment thereof according to the line f, i. e. in a manner such that the pump delivers at the highest density of charge γ_h the fuel amount b'_h, which is smaller than b_h, and at the lowest density of charge γ_n the fuel amount b'_n, which is larger than b_n. In order now to adapt the delivery amounts to the actual requirement according to line e, there is again inserted, intermediate the governor and the pump, an arrangement according to Fig. 2 in a manner such that with that position of the governor corresponding to the highest density of charge the direction of the longitudinal axis of the lever 6, 6a coincides with the direction of displacement of the lever joint 7. Thereafter, by turning the screw 18, the pump delivery is adjusted to the correct amount b_h corresponding to the highest density γ_h. Thereupon, by turning the screw 15, the leverage is so adjusted that it yields, with an adjustment of the governor in a position corresponding to the lowest density of charge γ_n, a decrease of the pump delivery to the correct amount b_n corresponding to this density of charge γ_n.

As shown in Fig. 4, the invention may be put into practice by using a one-armed gearing lever. The one end of this lever 23 is connected by a joint 24 with a rod 27, which is arranged in the stationary guide 13 for displacement in the direction of its longitudinal axis and which is connected for this purpose, by means of a member 28, 29 adapted to transmit longitudinal displacements only, with an adjusting screw 30 screwably arranged in the stationary nut 13a. This lever carries two spaced sliding sleeves 21 and 25, the sleeve 21 being connected through a joint 22 with the governor rod 2 guided in the stationary guide 3, 4, while the sleeve 25 is connected through a joint 26 with the pump adjusting rod 10 guided in the stationary guide 9. By turning the screw 30 the leverage of the lever 23 is varied in a manner similar to that described with respect to Fig. 2.

Fig. 5 again illustrates a one-armed gearing lever 34, which is supported at one end for oscillation about the fixed pivot 35. The governor rod 2 guided in the guides 3, 4 is connected, through an intermediate joint 31 and a lever 32, and by means of a joint 33, with the gearing lever 34, in about the center thereof. The free end of the lever 34 is provided in the form of an arcuate slot, wherein a joint member 39 is displaceably arranged, as best seen in Fig. 5a. A lever 37 is pivotally connected with the joint member 39 and is connected, through the joint 38, with the pump-adjusting rod 10. By a variation of the position of the joint member 39 in the slot 36 the leverage of the lever 34 may be adjusted in a manner such that to a particular throw of the governor there corresponds a larger or smaller adjusting movement of the pump adjusting rod 10.

Fig. 6 illustrates a practical embodiment of the invention according to Fig. 2, adapted for varying the fuel delivery of the fuel injection pumps of a multi-cylinder internal combustion engine of the injection type in dependency upon the density of the air charge supplied to the cylinders. In a casing 41 which is connected, by means of the inlet pipes 42, to the air intake pipe of the internal combustion engine, a governor 43 of the membrane box type is provided. The governor is positively connected with the governor rod guided in the bearings 45 and 46. The free end of the governor rod 44 includes a toothed portion 47 meshing with a toothed segment 48, which is connected with the end of an arm 50 of a double-armed lever 50, 50a. The arm 50a is arranged for displacement in a sleeve 51, which by a joint 52 is connected with a rod 54 guided in the fixed guide 53. Sleeve 51 is used to equalize inaccuracies occurring through the engagement of the teeth on segment 48 with rack 47. The radius of the toothed segment 48 is equal to the distance of the rod 54 from the toothed portion 47 of the governor rod 44. Equiaxially with respect to the rod 54 there is provided a rod 55 which is arranged for displacement in the guides 56 and 57 and includes the toothed portions 58 and 59. The toothed portions 58 and 59 coact with the toothed segments 60 and 61 of the adjusting members of the fuel injection pumps 62 and 63. The adjacent ends of the rods 54 and 55 are provided with opposed screw threads 65 and 66 and may be moved closer or further apart by a nut 67 engaging the screw threads. The double-armed lever 50, 50a is further provided with a slide sleeve 70, which by a joint 71 is connected with a rod 72, which is guided in the guide 73 fixed on the common support 74 so as to be displaceable in the direction of its longitudinal axis. The rod 72 is connected, through a member 75 adapted to transmit longitudinal displacements only, with the screw 77 which is arranged for displacement in an eye 76 provided in the common support 74, the screw 77 being provided with a head 78 adapted to facilitate the adjustment thereof.

A further embodiment of a similar arrangement for controlling the amount of delivery of fuel injection pumps is shown in Fig. 7 in connection with an internal combustion engine of the type where the working cylinders and the fuel pumps are arranged in two rows. The arrangement according to Fig. 7 is further distinguished in that the adjusting movements of the governor 43 are transmitted to the fuel pump adjusting rod by means of a power amplifier. For this purpose the governor 43 acts, by means of the governor rod 44, on a restoring control device, which comprises a slide valve 81 arranged for displacement in the control cylinder 80 and adapted to control the supply and discharge of a working medium to or from a working cylinder 82, and comprises further the piston 83 arranged for displacement in the working space, and the restoring lever 79. With the piston 83 of the restoring control device a rod consisting of the parts 84 and 84a is connected, which is guided in the guides 45 and 46 for displacement in the direction of its longitudinal axis. The adjacent ends of the parts 84 and 84a are provided with opposed threads 118 and 119, which are engaged

by an adjusting nut 117. The part 84a is moreover provided, on its free end, with a toothed portion 85, which coacts with the toothed segment 86 provided on the gearing member 50, 50a. The portion 50a of this gearing member carries an additional toothed segment 87, which meshes with the toothed portion 88 provided on the rod 89 which is arranged for longitudinal displacement in the guides 90, 91, 92, 93 and 94. The radii of the toothed segments 86 and 87 are provided equal to half the distance between the racks 85 and 88. The rod 89 carries on its ends additional toothed portions 95a and 95b, which coact with the toothed segments 96a and 96b, which are mounted on the hub bodies 98a and 98b which in turn are mounted for rotation about their axes 97a and 97b. With these hub bodies 98a and 98b there are further connected the toothed segments 99a and 99b, which coact with the toothed portions 100a and 100b provided on the rods 101a and 101b which are guided in the guides 102a, 102b—107a, 107b. The rods 101a and 101b carry further toothed portions 108a, 108b, 109a, 109b and 110a, 110b, which mesh with the toothed segments 114a, 114b, 115a, 115b and 116a, 116b, which are connected with the members adjusting the amount of fuel delivered by the fuel pumps 111a, 111b, 112a, 112b and 113a, 113b. The amount of leverage of the gearing lever 50, 50a is varied by the same portions 70—73 and 75—78, as described with reference to Fig. 6.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

We claim:

1. In a control mechanism for an engine, a governor, fuel dispensing means, and means for connecting said governor to said dispensing means; said connecting means comprising a lever, means joining said lever adjacent one end to said governor means, means joining said lever adjacent an opposite end to said fuel dispensing means, a fulcrum for said lever, and means mounting said fulcrum on said lever between the two joining means for movement to positions along said lever with the locus of said positions constituting the axis of said lever at a predetermined position within its range of angular movement.

2. In a control mechanism for an engine, a governor, fuel dispensing means, and means for connecting said governor to said dispensing means; said connecting means comprising a lever, rack and gear means for connecting one end of said lever to said governor means, pivotal means for connecting an opposite end of said lever to said fuel dispensing means, a fulcrum for said lever, and means mounting said fulcrum on said lever between said rack and gear means and said pivotal means for movement to positions along said lever with the locus of said positions constituting the axis of said lever at a predetermined position within its range of angular movement.

3. In a control mechanism for an engine, a governor, fuel dispensing means, and means for connecting said governor to said dispensing means; said connecting means comprising a lever, rack and gear means for connecting one end of said lever to said governor means, pivotal means for connecting an opposite end of said lever to said fuel dispensing means, a pivotally mounted sleeve slidably mounted upon said lever intermediate said rack and gear means and said pivotal means, and means for moving said sleeve to shift the fulcrum for said lever to positions along said lever with the locus of said positions constituting the axis of said lever at a predetermined position within its range of angular movement.

4. A control device for a variable feed fuel pump of an internal combustion engine comprising a governor, a rod displaceable in the direction of its longitudinal length by said governor, a second rod movable in the direction of its longitudinal length for adjusting the fuel pump, a lever arm interconnecting said first and second rods, a fulcrum for said lever arm, means mounting said fulcrum on said lever arm between said first rod and said second rod for movement to positions along said lever arm with the locus of said positions constituting the axis of said lever arm at a predetermined position within its range of angular movement.

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