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FUEL INJECTION MECHANISM

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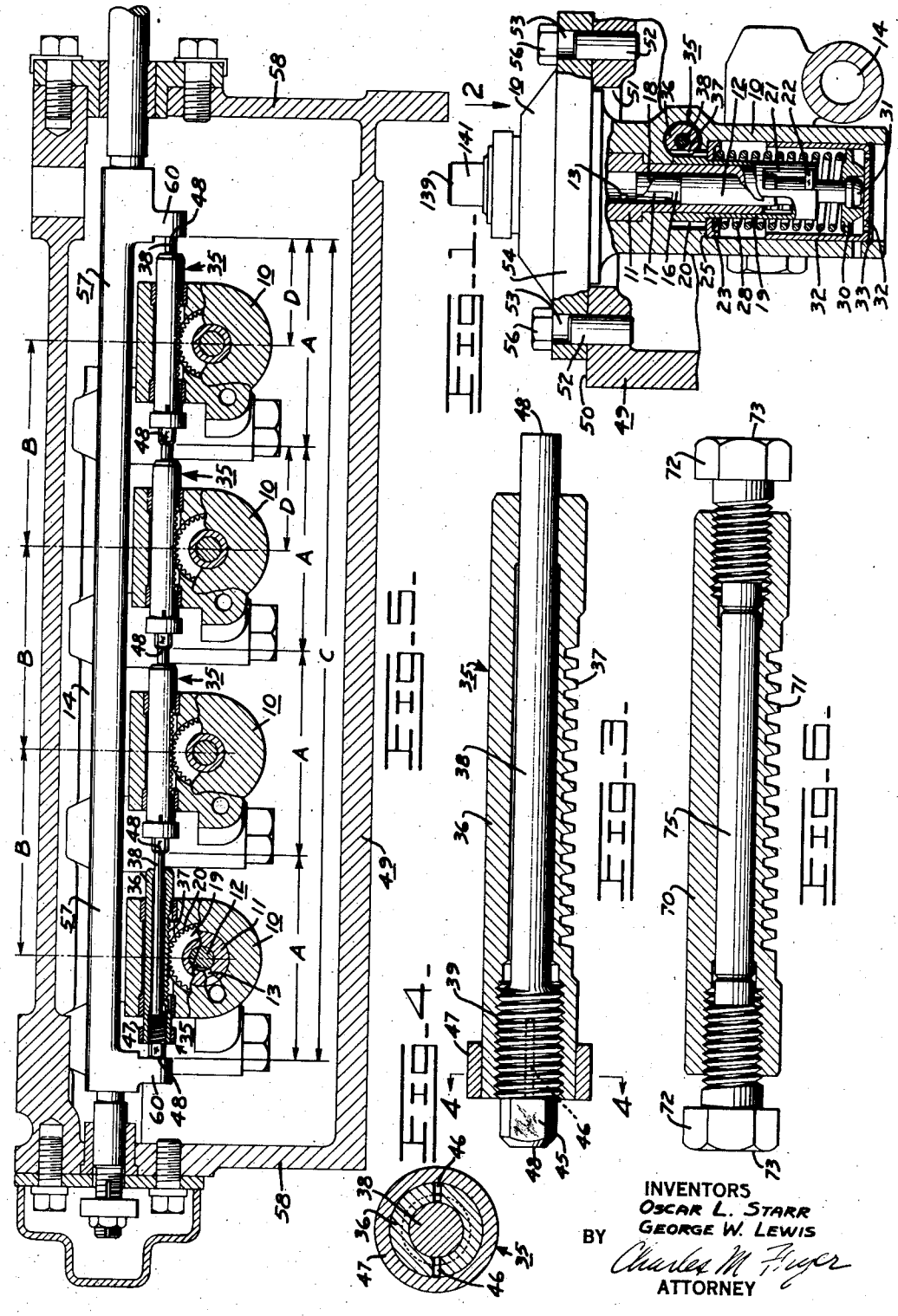


FIG-1-

FIG-3-

FIG-4-

FIG-6-

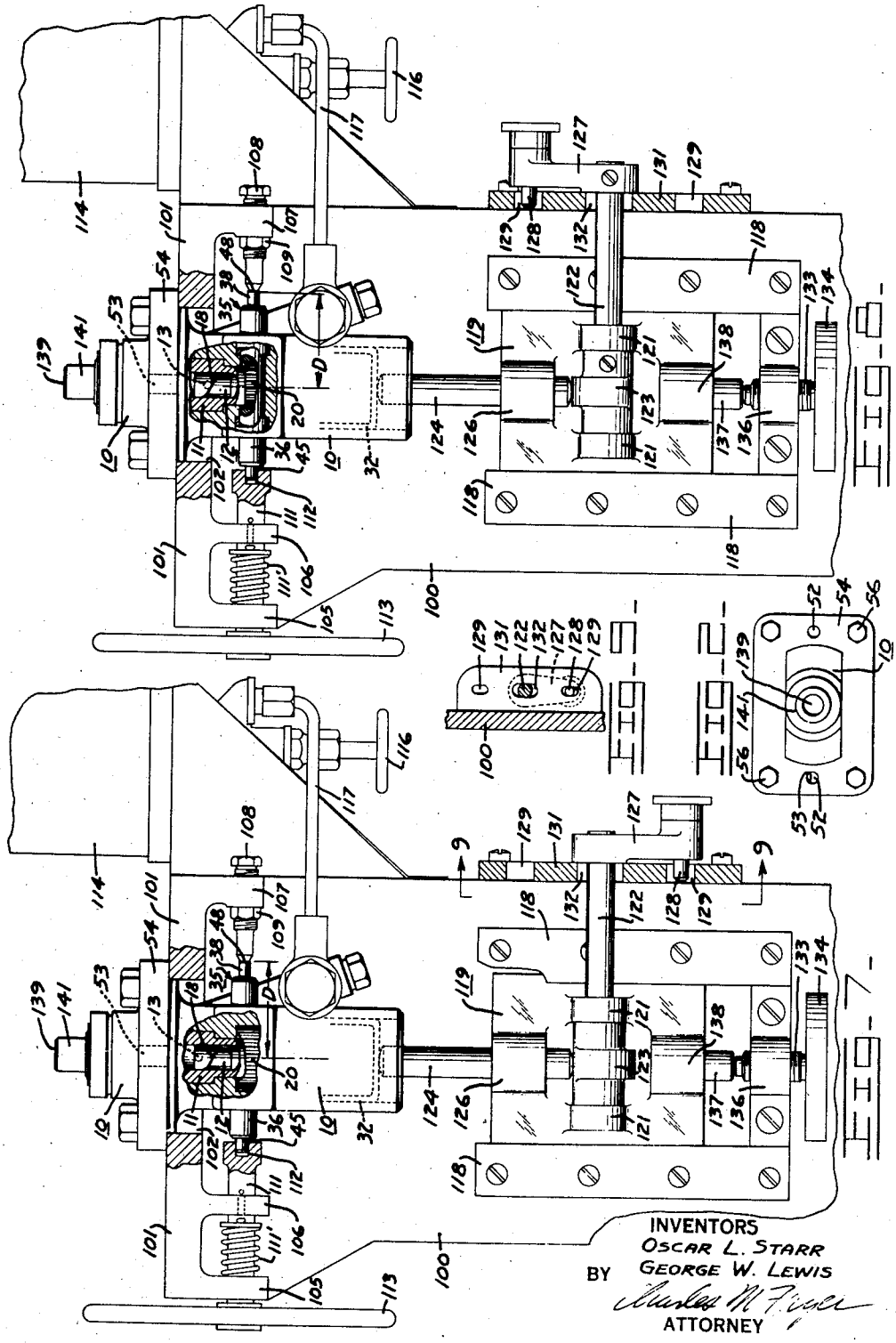
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FUEL INJECTION MECHANISM

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7 Claims. (Cl. 103—41)

Our invention relates to fuel injection mechanism, and more particularly to fuel injection mechanism of the type having parts which are mounted for relative angular adjustment to control fuel injection. Fuel injection mechanism of the character described is very common and is being employed in numerous forms.

A type of such fuel injection mechanism, in the form of a fuel injection pump, is disclosed in Fig. 1, and comprises a body member or pump casing 10 having rigidly positioned therein pump barrel or sleeve 11 in which a pump plunger 12 is closely fitted for both angular adjustment and axial reciprocation. Pump barrel 11 is provided with an aperture or orifice 13 connected by suitable passage means (not shown) with fuel supply manifold 14 in turn connected to a suitable source of fuel supply. Thus, fuel can pass into sleeve 11 when the upper edge of plunger 12 is below orifice 13. When the plunger is moved upwardly, it is apparent that orifice 13 can be closed to force fuel under pressure into a conduit (not shown) connected with a cylinder of the engine.

Means, which may be broadly considered as valve means, is provided to control the quantity of fuel injected. An annular groove 16 is formed in the plunger below the upper edge thereof, and a slot 17 leads from such groove to the upper edge of the plunger. From adjacent the top at one side of slot 17 is formed a by-pass ledge or edge 18 which has a constant angle slant downwardly to groove 16. By-pass edge 18 is adapted to cooperate with orifice 13 to establish communication between the space above the upper edge of the plunger and groove 16, through slot 17. Because of the angular position of edge 18, it is apparent that the time of such by-passing may be controlled by angular adjustment of plunger 12, to thereby control the quantity of fuel which the pump can inject. The mechanism whereby the plunger can be angularly adjusted as it is reciprocated, comprises sleeve 19 journalled for rotation about barrel 11, and which is provided adjacent its upper end with gear teeth 20 and adjacent its lower end with axially extending and aligned slots 21 (only one of which appears in Fig. 1). Outwardly extending arms 22 secured to pump plunger 12, slidably engage in said slots 21 during reciprocation of the pump. Sleeve 19 is held in position by cup-shaped retaining member 23 pressed against shoudler 25 in pump casing 10 by spring 28. The lower end of spring 28 presses downwardly against keeper 30 which engages over an enlarged head 31 at the lower end of plunger 12 to thereby constantly urge plunger 12 in a downward direction; a suitable guide cup 32 being provided to take up side thrust and limit downward movement when it engages retainer ring 33. Plunger 12 is axially reciprocated by any suitable cam and tappet means (not shown) operated by the engine and which contacts the lower face of guide member 32.

Control means 35 including a rack is slidably mounted for axial reciprocation in casing 10, and has gear teeth for engagement with gear teeth 20 on sleeve 19. Thus, it is seen that any axial movement of control means 35 effects, through gear teeth 20, rotation or angular adjustment of sleeve 19 about plunger barrel 11, and consequently angular adjustment of plunger 12 through the sliding connection between slots 21 in sleeve 19 and arms 22. The control means 35 is usually connected to the governor of the engine so that the injection of fuel is controlled automatically; and for a multiple cylinder engine a plurality of such control means is connected for simultaneous operation.

In the type of fuel injection mechanism to which the invention relates, manufacturing tolerances are very small, and all parts are machined with exact precision in an effort to produce pumps having exactly the same characteristics with reference to their timing and fuel metering, so that when a plurality of pumps are employed on a multiple cylinder engine, the engine will operate smoothly and efficiently. In this respect, it is necessary for all of the pump plungers to have exactly the same effective angular position for any given phase of fuel injection, so that no one pump meters more or less fuel than another pump for such phase. Although it might be possible by individual hand work to manufacture a plurality of pumps with dimensions so identical as to enable all the pumps to have exactly the same timing at any given angular position of the plungers thereof when the pumps are installed on the engine, there exists quite a problem in producing or obtaining this result in the commercial production of pumps in large quantities.

With respect to multiple cylinder engines, it is also desirable to enable the pumps to be interchangeably mounted on the engine, so that in assembling the pumps thereon they can be positioned in any order and still give synchronous timing without further adjustment. Also, it is desirable that in case of replacement of any given pump, by a new pump, the new pump can be mounted on the engine and be in proper timing position without further timing adjustment. The inability to manufacture commercially

pumps having exactly the same dimensions, has presented a problem in this connection.

Our invention is designed to overcome the problems discussed, and has as its objects, among others, the provision of improved:

(1) Simple means enabling adjustment to secure corresponding and accurate timing for all of a plurality of fuel injection mechanisms of the character described;

(2) Means, of the character related, permitting complete interchangeability of the fuel injection mechanism, thus enabling any of such mechanism to be replaced without affecting the timing;

(3) Means, of the character related, which will enable such adjustment of the mechanism to be made easily and conveniently before assembly thereof on the engine, and

(4) Means, of the character related, which is of simple and economical construction.

Other objects of the invention will become apparent from a perusal of the following description thereof.

In general terms, the construction of our invention comprises control mechanism having relatively movable parts which can be adjusted without altering the overall length of such control mechanism, to thereby adjust the relative angular position of the fuel metering parts in a fuel injection device of the character related. In the form of invention illustrated, the control mechanism comprises the rack or element connected to effect angular adjustment of the pump plunger, and adjustable means mounted for relative movement axially of the rack or element. Such adjustable means has a motion imparting connection with the rack or element, preferably in the form of a threaded connection, and the overall length of the adjustable means is greater than the length of the rack; the adjustable means being of predetermined length and extending beyond both ends of the control rack thereby determining the overall length of the entire control mechanism. Thus, by virtue of the motion imparting connection, movement of the control rack can be effected to adjust the angular position of the plunger when the adjustable means is restrained against axial movement. At the same time, the overall length of the control mechanism will not be changed. In a plurality of pumps, the overall length of each of the described control mechanisms is made exactly the same.

The pumps are adapted for mounting on the engine with the described control mechanisms of the several pumps in free end to end abutting or contacting relationship, and all in axial alignment. An operating member adapted for connection with the governor of the engine is provided and has spaced means engaging the outer ends of the outermost control mechanisms. Such operating member is movable to effect simultaneous movement of all of the control mechanisms. The combined length of the control mechanisms is exactly equal to the length or distance between the spaced means of the operating member; no clearance existing between the abutting ends of the control mechanisms. Hence, movement of the control mechanisms will be effected as a unit together solely by virtue of surface to surface contact therebetween, and all pumps can be simultaneously controlled. Also, no play can develop to alter timing of the pumps, as occurs in heretofore employed link and pin connections.

As a result of the described arrangement, it is apparent that each pump can be timed beforehand without effecting a change in the overall length of the control mechanism for the plunger, to cause each pump to have exactly the same timing relationship as the other pumps. Inasmuch as the overall length of the control mechanism is not changed by such adjustment and since all the control mechanisms are of exactly the same length, the pumps can be mounted on the engine in any order, and any pump can be removed and replaced by another pump without the necessity of making any timing adjustment on the engine. Thus, interchangeability of the pumps obtains.

Reference will now be made to the drawings for a more detailed description of the invention. In the drawings:

Fig. 1 is a vertical section, partly in elevation, of a type of pump in which our invention may be employed, parts being broken away to disclose clearly the construction. The view also illustrates the preferred manner of mounting and aligning the pump on an engine.

Fig. 2 is a plan view, illustrating the pump mounting and aligning means, looking in the direction of arrow 2 in Fig. 1.

Fig. 3 is an enlarged longitudinal sectional view, partly in elevation, of a preferred form of control mechanism for angularly adjusting the pump plunger.

Fig. 4 is a vertical section taken in a plane indicated by the line 4—4 in Fig. 3.

Fig. 5 is a longitudinal section, partly in elevation, through a pump housing on which the pumps are mounted, and illustrates the relation of the pumps to each other and to the operating member therefor.

Fig. 6 is an enlarged longitudinal sectional view of a modified form of control mechanism, similar to that illustrated by Fig. 3.

Fig. 7 is a more or less schematic elevational view, in which parts of a pump are shown in section, illustrating a preferred type of apparatus for timing the pumps beforehand.

Fig. 8 is a view similar to Fig. 7, illustrating the apparatus having parts thereof in a different position from that shown in Fig. 7.

Fig. 9 is a fragmentary vertical section, on a reduced scale, taken in a plane indicated by line 9—9 in Fig. 7.

The preferred control mechanism 35, for angularly adjusting the plunger (Figs. 1 and 3), is mounted for axial reciprocation in pump body or casing 10, and includes rack element 36 which is hollow to provide an axially extending passage therethrough and which has teeth 37 formed thereon for engagement with teeth 20 of sleeve 19, so that any axial movement of the control mechanisms is transmitted by sleeve 19, in the manner previously related, to thereby effect angular adjustment of the pump plunger 12 with reference to orifice 13 in pump barrel 11. Also included in the control mechanism 35, is adjustable means in the form of pin member 38 mounted within rack element 36. Pin member 38 has a motion imparting threaded connection 39 with rack element 36 adjacent one end thereof, and projects beyond both ends of the rack element to thus fix the overall length of control mechanism 35. All of the pin members 38 in a plurality of pumps, are made of exactly the same predetermined length.

Adjacent one end thereof, pin 38 is formed with a flat 45 for engagement by any suitable tool to effect adjustment relative to rack element

36. The internally threaded end portion of rack element 36 is formed with axially extending slots 46 (Figs. 3 and 4) whereby, after rack 36 has been properly adjusted with relation to pin 38 to effect the correct timing of the pump, a clamping ring 47 may be press-fitted over the threaded end portion of rack 36 to wedge the threads and hold the parts in proper adjustment. This provides a simple and economical method of securing rack 36 in correct relation to pin 38, and also provides a means for preventing an unskilled workman from tampering with the timing of the pump after it has been correctly timed by any suitable method. An ordinary lock nut could be employed for this purpose but is objectionable because it can be readily tampered with. Both ends 48 of the pin 38 are accurately machined or ground to provide perfectly flat surfaces normal to the axis of reciprocation of the control mechanism, to enable accurate end to end abutting relationship of the various pump control mechanisms when the pumps are assembled on the engine in a manner to be subsequently described.

From the preceding description, it is apparent that if pin 38 is constrained against axial movement, for example by abutting an end 48 thereof against a suitable fixed abutment, and rotated, the rack 36 will be moved axially of the pin 38 to thereby angularly adjust pump plunger 12. Thus, the angular relation of plunger 12 with relation to orifice 13, can be delicately adjusted beforehand, so that all of a plurality of pumps will have exactly the same timing for any given phase of fuel injection. At the same time, the overall length of the control mechanism will not be changed; such length being made exactly the same for all pumps, as was previously related.

A plurality of pumps, which have previously been adjusted so that all of the pumps have the same timed relation for a given phase of fuel injection, are mounted on the engine and controlled simultaneously, by means illustrated in Figs. 1, 2 and 5. Pump housing 49, on the engine, is provided with an accurately machined top 50 having apertures 51 to receive the pump casings 10. Such top has pump aligning dowel pins 52 accurately positioned adjacent each aperture 51, and which are adapted to center properly and fix each pump by engagement in dowel pin apertures 53 formed accurately in horizontal flange 54 on pump casing 10. Cap screws 56 serve to fasten each pump which cannot become misaligned upon tightening of such screws because of the centering effected by the dowel pins.

The positioning of dowel pins 52 for the various pumps and the length of pump control mechanisms 35 is such that each pump can be individually mounted, and when all of the pumps are so mounted the adjacent ends 48 of all the control mechanisms 35 will be in exact end to end abutting relationship, as is illustrated in Fig. 5. Hence, any pump can be very readily removed and a new pump readily inserted in its place. In Fig. 5, the overall length of each pump control mechanism 35 is indicated by reference character A, and the distance between the axes of adjacent pumps is indicated by reference character B, such distance being the same as length A.

All the pumps are operated or adjusted simultaneously during operation of the engine by operating member 57 connected with both the hand throttle control and the engine governor (not shown), and mounted for axial reciprocation along an axis parallel to the axis of control mechanisms 35. Member 57 is slidably mounted in the opposite end walls 58 of pump housing 49, and has spaced ears or projections 60. The inner surfaces of such ears are accurately machined to engage the outer ends of the outermost control mechanisms 35, and are spaced apart a distance C exactly equal to the combined lengths A of the control mechanisms. The individual pump control mechanisms 35 are, in effect, locked together between ears 60 of control member 57, and any movement of member 57 must necessarily effect simultaneous movement of all of the control mechanisms an equal amount. Thus, operation of the control member 57 effects simultaneous operation of control mechanisms 35, without play, to adjust synchronously all the pumps simultaneously, during operation of the engine.

In the modified form of control mechanism illustrated in Fig. 6, the rack element 70 is also tubular and has suitable teeth 71 for engagement with teeth 20 on sleeve 19 in the pump. Threaded into the internally threaded ends of rack 70 are cap screws 72 which engage, at their inner ends, the ends of a pin 75 which is slidably mounted in the axial passage in rack 70. The combined length of cap screws 72 and pin 75, which together form the means adjustable relative to rack 70, is made the same for all the control mechanisms. By merely loosening one cap screw 72 and tightening the other cap screw 72, the relative position of the teeth on rack 70 can be varied with relation to the flat ends 73 of cap screws 72, to thereby effect adjustment or the timing of the pump without varying the overall length of the control mechanism, in the manner previously related with reference to the preferred construction.

The pumps may be adjusted beforehand in any suitable manner to effect synchronous timing for all the pumps. Preferably, the pumps are calibrated or standardized before assembly, in apparatus similar to that disclosed in our assignee's copending application, Serial No. 696,960, filed November 7, 1933, by Carl G. A. Rosen and resulting in U. S. Patent No. 2,106,932, granted February 1, 1938. This enables all of the pumps to be so calibrated or timed beforehand that the duration of fuel injection of each pump may be exactly the same for any given phase of fuel injection determined by the angular position of the pump plungers, when the pumps are installed on the engine.

Briefly, such preferred calibrating apparatus (Figs. 7 and 8) comprises a vertical frame or fixture 100 provided at its upper edge with a horizontal flange 101 having aperture 102 to receive pump casing 10, and also depending bosses 105, 106 and 107 formed integrally adjacent the lower edge thereof. Threaded in boss 107 is an adjustable screw 108 which is adjusted to a fixed position and then securely locked in that position by lock nut 109. Each pump, when being calibrated, is adapted for mounting on flange 101 by the same type of means, including dowels for centering properly the pump, as that employed on the engine; and screw 108 is so adjusted as to provide the same distance D between the inner end thereof and the axis of the pump plunger as exists between the end of each control mechanism 35 of a pump and the axis of the plunger of the adjacent pump when assembled on the engine.

Journalled and slidably mounted in bosses 105

and 106 is a shaft 111 urged inwardly by spring 111' and provided at one end with a recess 112, and at the other end with an adjusting wheel 113. Recess 112 is adapted to receive the flat portion 45 of the pin 38 of control mechanism 35, to effect relative adjustment between the pin and the rack 36 upon turning of wheel 113. Secured at one side of the vertical frame 100 adjacent the horizontal flange 101, is a fuel tank 114 provided with a control valve 116 and a supply conduit 117 adapted for connection with the pump to supply fuel through pump orifice 13. Slidably mounted beneath horizontal flange 101 in suitable guideways 118, is a plate 119, having axially aligned horizontally positioned spaced bosses 121 in which horizontal shaft 122 is journalled. Shaft 122 has secured for rotation therewith cam 123 upon which rests a vertical pin 124 slidably mounted in boss 126 positioned above spaced bosses 121, and adapted to engage the lower face of guide cup 32. It is thus seen that rotation of shaft 122 will effect lifting of pin 124 a predetermined distance fixed by the high point and the low point of cam 123, to thereby elevate pump plunger 12 the same distance. In Fig. 7, the lower end of pin 124 is shown resting on the low point of the cam, and in Fig. 8 on the high point.

Rotation of cam 123 can be effected by handle 127 having spring-pressed pin 128 adapted to be held in either of elongated apertures 129 in plate 131 secured to the side of fixture 100. Plate 131 is also provided with elongated aperture 132 through which shaft 122 projects. Although apertures 129 and 132 are larger than the sections through pin 128 and shaft 122, respectively, it will be noted (Fig. 9) that their width is the same as that of pin 128 and shaft 122, respectively. Thus, slidable plate 119 can be adjusted in a vertical direction; and in any adusted position thereof, apertures 129 in cooperation with pin 128, will hold cam 123 in proper high and low positions.

Vertical adjustment of plate 119 and the mechanism mounted for adjustment therewith, for a purpose to be explained hereinafter, is effected by adjustable screw 133 having adjusting wheel 134. Screw 133 is threaded in boss 136 fixedly secured to frame 100, and bears against pin 137 fixedly mounted in boss 138 which is fixedly mounted on slide plate 119 below spaced bosses 121.

The preferred method of calibrating a fuel injection pump in the described apparatus to obtain synchronous timing of all pumps manufactured, will now be described. In the manufacture thereof, all pumps are made to have exactly the same length from the upper edge of plunger 12 to the lower face or surface of guide cup 32, by any suitable method. Our assignee's previously referred to patent to Carl G. A. Rosen, No. 2,106,932, disclose a simple way of obtaining this result.

Each complete pump including control mechanism 35 thereon, is fixedly mounted on horizontal flange 101 to project through aperture 102 therein; the dowel pins serving to center accurately all the pumps in the manner previously explained. The right end 48 of pin 38 (Fig. 7) of control mechanism 35 is held in contact against the inner end of adjusted screw 108 by spring 111' which urges shaft 111 inwardly. Shaft 122 on slidable plate 119 is in a position so that vertically slidable pin 124 rests on the low point of cam 123; and the lower adjusting screw 133 is in such position as to enable the upper edge of plunger 12 to be below orifice 13, thereby allowing fuel to flow through orifice 13 upon connection of the pump with conduit 117 and upon opening of valve 116.

Fuel will then flow through orifice 13 and out through the opening 139 in the top of the pump nipple 141. Screw 133 is then adjusted to lift the parts so that the upper edge of plunger 12 reaches the position shown in Fig. 7 where the plunger just closes orifice 13 completely and the fuel flow is consequently shut off. The operator can accurately obtain this exact position for all pumps because when it is reached, fuel will cease to flow through opening 139. Such position corresponds to a fixed point for all pumps for commencement of fuel injection when the pumps are installed on the engine.

After such point is reached, handle 127 is next turned to raise cam 123, without plate 119 being moved, to present its high point to pin 124 and thereby effect lifting of plunger 12 a predetermined distance. This position is illustrated in Fig. 8. At such position, adjusting wheel 113 is turned to adjust angularly pump plunger 12, in the manner previously related, so that slanting edge 18 on the plunger just opens orifice 13 to allow fuel to flow again out through opening 139. This position, thus, determines a cut-off or bypass point for a fixed distance of axial travel of the pump plunger; and in such position pin 38 and rack 36 are securely locked together by the means previously described. The pump is then removed, and succeeding pumps are calibrated in the same manner.

Inasmuch as all pumps will have for a given travel at a predetermined angular position of the plunger, the same points of commencement and termination of fuel injection, they will all be synchronously timed for any travel of the plunger and any angular position thereof inasmuch as slanting edge 18 is of constant angle. Furthermore, because of the fact that all control mechanisms 35 are of exactly the same length which is not changed by the described adjustment, the pumps will be accurately timed or synchronized when positioned on the engine as shown in Fig. 5.

From the preceding description, it will be seen that the control mechanism of our invention is simple to manufacture as it embodies a comparatively few number of parts which can be accurately machined, and at the same time such control mechanism provides an accurate and simple arrangement for obtaining synchronous timing of the pumps.

We, therefore, claim as our invention:

1. Control mechanism for a fuel injection device adapted to be detachably mounted on an engine with other similar detachably mounted devices and of the type having members relatively adjustable to control fuel injection, comprising an element having an axially extending passage therethrough, and means extending through said passage beyond both of the opposite ends of said element and having a threaded connection with said element to effect relative axial adjustment with respect thereto, said means being of a predetermined length and having its ends formed for freely disengageable surface contact with corresponding means of similar devices.

2. An interchangeable fuel injection device comprising members relatively adjustable to control fuel injection, and control mechanism therefor, said control mechanism being of a prede-

termined length and having its ends formed for end to end abutting contact with similar control mechanisms of similar devices when mounted on an engine, and including means relatively adjustable axially to time said members without changing the overall length of said control mechanism.

3. A fuel injection device comprising members relatively adjustable to control fuel injection, and control mechanism therefor having its ends formed for freely disengageable end to end abutting contact with similar control mechanisms of similar devices when mounted on an engine; said control mechanism including an element mounted for movement on said device and connected with one of said members, and means extending beyond both of the opposite ends of said element and relatively adjustable axially with respect thereto.

4. An interchangeable fuel injection pump adapted for detachable mounting on an engine in interconnected relationship with other similar detachably mounted pumps and comprising a plunger member and a cylinder member mounted for relative angular adjustment and having cooperating valve means of the type including a slanting edge which controls fuel injection upon relative angular adjustment of said members; and control mechanism for said members comprising an element connected to one of said members and mounted on said pump for axial reciprocation and having a passage therethrough, and means of predetermined length extending through said passage beyond both of the opposite ends of said element and having a motion imparting connection with said element to provide for relative axial adjustment of said element with respect to such means of predetermined length and thereby enable adjustment of the member connected with said element without changing the overall length of said control mechanism; said means of predetermined length being formed for freely disengageable contact with similar means of said similar pumps whereby said angular adjustment can be effected without affecting proper interconnection between pumps.

5. An interchangeable fuel injection pump adapted for detachable mounting on an engine in interconnected relationship with other similar detachably mounted pumps and comprising a plunger member and a cylinder member mounted for relative angular adjustment and having cooperating valve means of the type including a slanting edge which controls fuel injection upon relative angular adjustment of said members; and control mechanism for said members comprising a rack mounted on said pump for axial reciprocation and connected to one of said members, said rack having a passage extending axially therethrough, and means of predetermined length extending through said passage beyond both of the opposite ends of said rack and having a motion imparting threaded connection with said rack to provide for relative axial adjustment of said rack with respect to such means of predetermined length and thereby enable adjustment of the member connected with said rack without changing the overall length of said control mechanism; said means of predetermined length being formed for freely disengageable contact with similar means of said similar pumps whereby said angular adjustment can be effected without affecting proper interconnection between pumps.

6. A fuel injection assembly for a multi-cylinder engine of the compression ignition type comprising a plurality of similar interchangeable fuel injection devices each of which is preadjusted to a definite standard and has members relatively adjustable to control fuel injection and includes control mechanism for effecting relative adjustment between said members, said control mechanisms being in freely disengageable end to end engagement with adjacent end portions of adjacent control mechanisms under all operating conditions of said assembly to provide for movement of all of said control mechanisms simultaneously in either endwise direction and to allow for ready removal or insertion of any of said devices; each control mechanism comprising an axially reciprocable element, and means of predetermined length extending beyond both of the opposite ends of said element and adjustable axially relative to said element without changing the overall length of said control mechanism; and means enabling all of said control mechanisms to be held together in said freely disengageable end to end engagement.

7. A fuel injection assembly for a multi-cylinder engine of the compression ignition type comprising a plurality of similar interchangeable fuel injection devices each of which is preadjusted to a definite standard and has members relatively adjustable to control fuel injection and includes control mechanism for effecting relative adjustment between said members, said control mechanisms being in freely disengageable end to end engagement with adjacent end portions of adjacent control mechanisms under all operating conditions of said assembly to provide for movement of all of said control mechanisms simultaneously in either endwise direction and to allow for ready removal or insertion of any of said devices; each control mechanism comprising an axially reciprocable element, and means of predetermined length extending beyond both of the opposite ends of said element and adjustable axially relative to said element without changing the overall length of said control mechanism; and a movable member having spaced apart means for cooperating with the outermost of said control mechanism to hold them together and effect simultaneous movement of all of said control mechanisms as a unit in either direction.

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