Jan. 23, 1951 V. D. ROOSA 2,538,982

FUEL PUMP

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Fig. 11

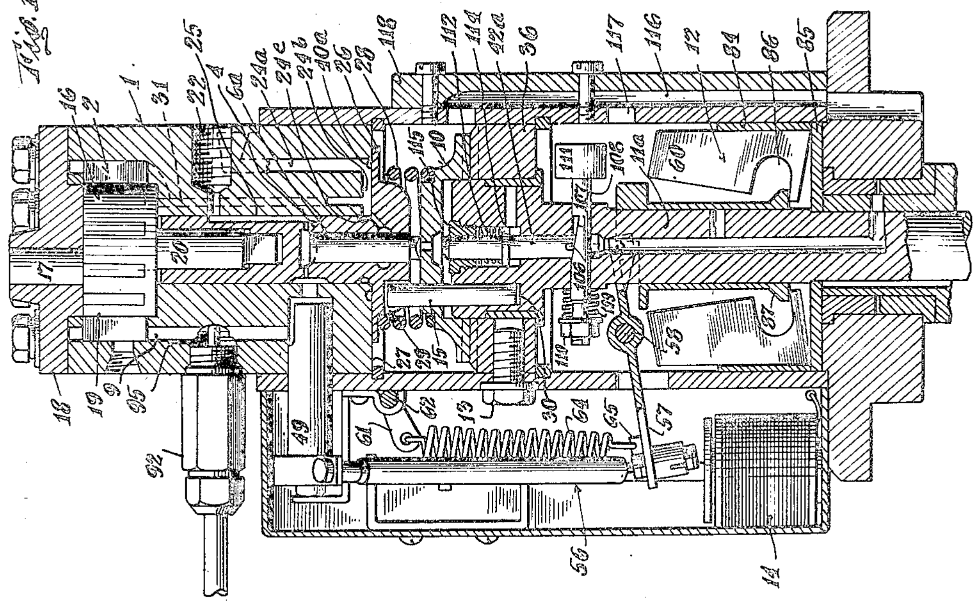
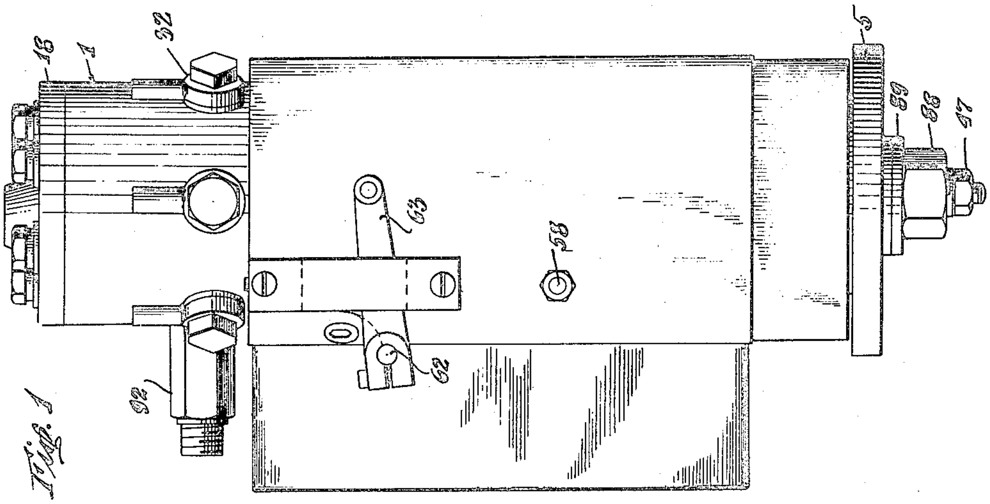


Fig. 1



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FUEL PUMP

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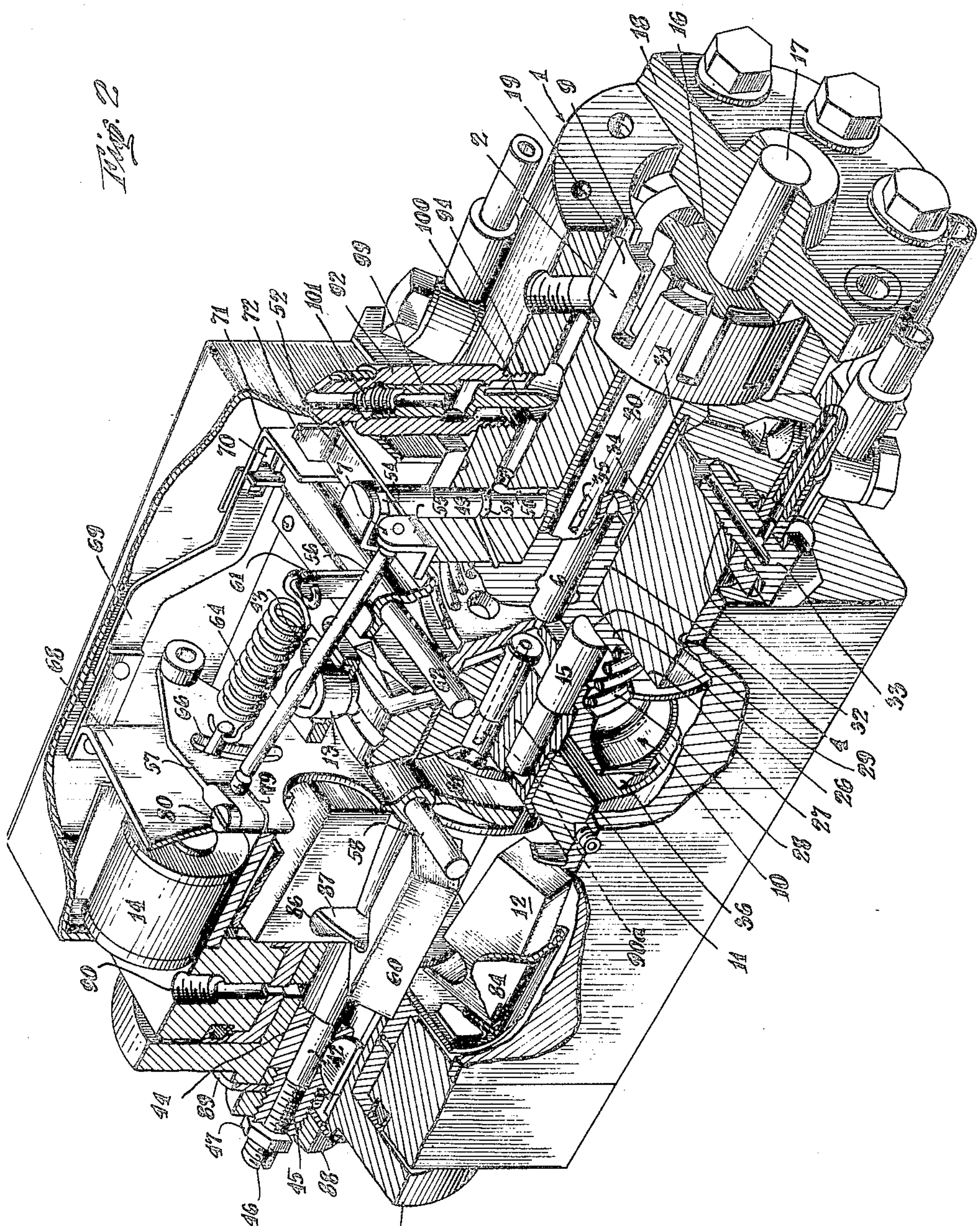

Fig. 2

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FUEL PUMP

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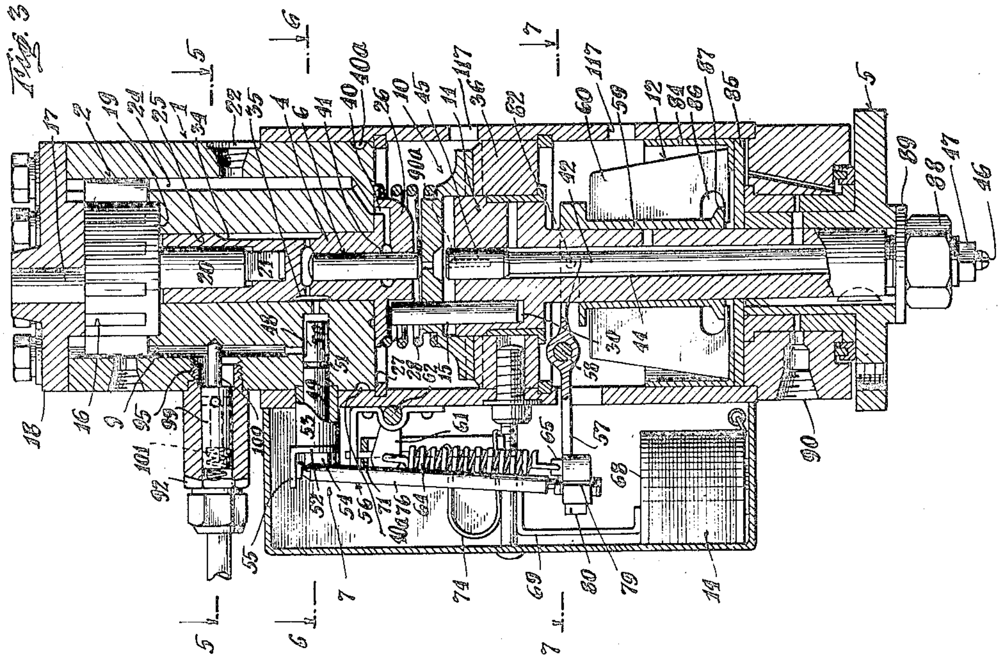
Fig. 3



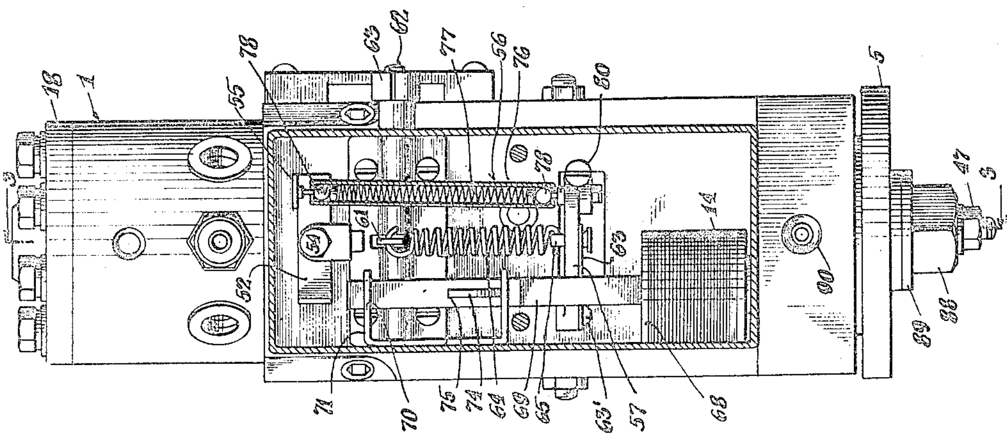


Fig. 4

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FUEL PUMP

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Fig. 10

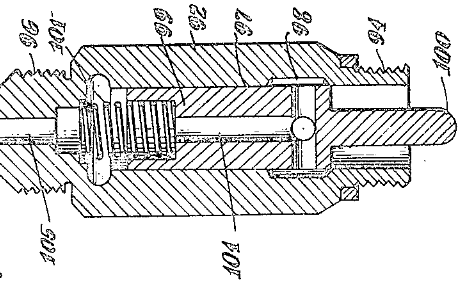


Fig. 8

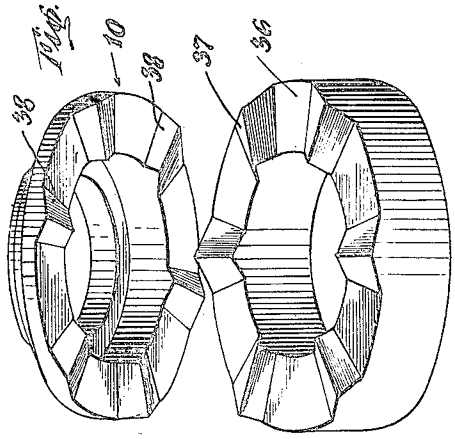


Fig. 6

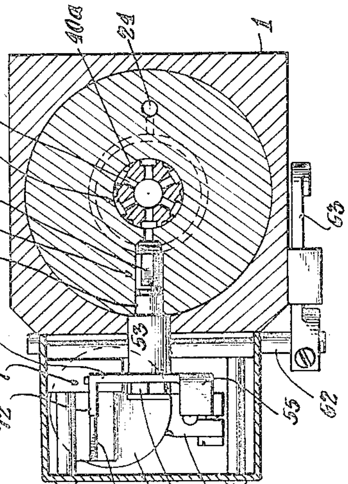


Fig. 9

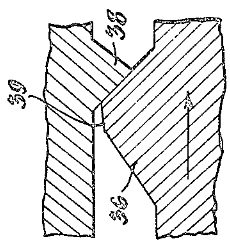


Fig. 5

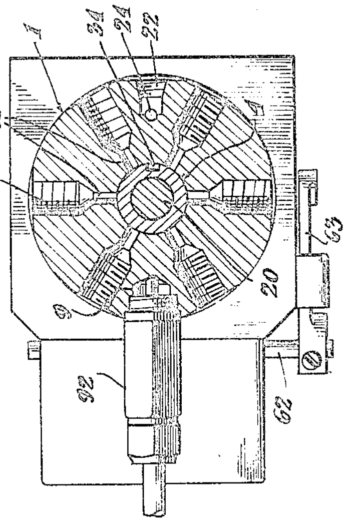
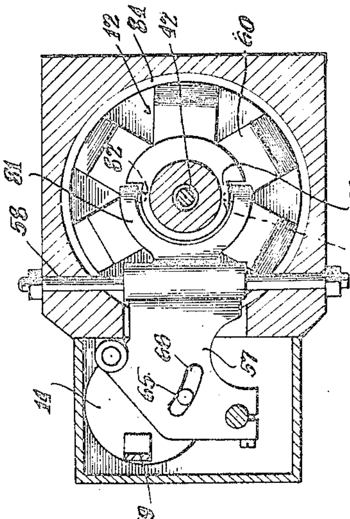


Fig. 7



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UNITED STATES PATENT OFFICE

2,538,982

FUEL PUMP

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Application June 30, 1945, Serial No. 602,476

29 Claims. (Cl. 103—5)

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The present invention relates to fuel pumps for internal combustion engines and the like, and is an improvement upon my prior Patent No. 2,253,188 granted July 11, 1944.

It is desirable that fuel pumps for internal combustion engines be compact, efficient and effective over a wide speed range, effectively governed to provide substantially constant speed with widely varying loads, and at the same time, simple in construction with a minimum number of parts, so that the cost of production will be small. The present invention aims to accomplish these objects by combining in an efficient manner a pick-up pump, a single piston pump for supplying fuel charges and an effective governor for controlling the speed over a wide range of loads.

An object of the invention is to provide a fuel pump simple in construction with automatic means for accurately controlling the amount of fuel fed to an engine.

Another object of the invention is to combine in an efficient manner a fuel charging or pick-up pump with a single piston pump for supplying successive fuel charges in such a manner as to simplify the pump construction with the employment of common means to drive both, one from the other.

A further object of the invention is to combine in an effective manner the fuel charging or pick-up pump with a piston pump for supplying successive fuel charges and a governor in substantially a single unit in such manner as to simplify the pump and governor construction with the employment of common means to drive all of them.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

A preferred embodiment of the invention has been chosen for purposes of illustration and description, and is shown in accompanying drawings, wherein:

Fig. 1 is a side elevational view of a preferred embodiment of the fuel pump;

Fig. 2 is a perspective view of the preferred embodiment broken away to show the interior thereof;

Fig. 3 is a sectional view along the line 3—3 of Fig. 4;

Fig. 4 is a top plan view with the top of the

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cover for the meter parts sectioned to show the interior thereof;

Fig. 5 is a sectional view along the line 5—5 of Fig. 3, illustrating the outlets from the fuel distributor to the engine cylinders;

Fig. 6 is a sectional view along the line 6—6 of Fig. 3, illustrating the path of the fuel through the fuel distributor to the single piston pump;

Fig. 7 is a sectional view along the line 7—7 of Fig. 3, illustrating features of the connection between the governor and the fuel metering valve;

Fig. 8 is a perspective view illustrating a preferred embodiment of cam together with the preferred embodiment of the member actuated thereby;

Fig. 9 is a detailed view showing the operation of the cam and the member actuated thereby with modified cam lobes;

Fig. 10 is a sectional view of the preferred embodiment of the relief valve; and

Fig. 11 is a sectional view illustrating a modification of the fuel pump.

Described generally and referring more particularly to Figs. 1 to 4 of the drawings, the preferred embodiment of the invention comprises an outer casing or base 1 having a pick-up pump 2 in one end thereof operatively connected to a fuel distributor 4 which receives fuel from the pick-up pump through a metering valve 7 and a conduit 9. The fuel distributor 4 is rotated by means of a pin in a central member 11. The latter extends centrally and longitudinally of the pump with a drive flange or disc 5 on its protruding end which is operatively connected to the engine on which the pump is mounted. A piston pump 6 is fitted into a chamber in the fuel distributor 4 and is reciprocated by means of an actuator 10 rotating on the surface of the stationary cam 36, adjacent the upper end of the member 11. Thus as the flange 5 is rotated, the central part of the pump rotates, including the fuel distributor 4, the actuator 10 for the piston pump, and the inner member of the pick-up pump 2. The rotation of the distributor 4 connects the conduit 9 through the metering valve periodically to the chamber above the piston pump and also connects this chamber periodically to the engine cylinders for delivering fuel thereto.

A governor 12 is mounted to rotate with the central part of the pump and is operatively connected to control the metering valve 7 which determines the amount of fuel delivered to the piston pump. An electro magnet 14 is operatively connected to the metering valve to shut off the supply of fuel when the engine switch is thrown. The preferred embodiment includes in a single unit the pick-up pump 2, the fuel distributor 4, the metering valve 7, the piston pump 6, the cam for operating the piston, and the governor 12 operatively connected to the fuel metering valve. The several parts are driven about the same axis and from the same drive. The above general description will be helpful in obtaining an understanding of the fuel pump, the parts of which will now be described in more detail without any intention of limiting the invention beyond its true and comprehensive scope in the art.

While the fuel pump may be mounted either vertically or horizontally, in the preferred embodiment the pump is shown mounted horizontally and has an outer casing 1 which may be bolted at its lower side to a suitable support on the engine. The drive flange or disc 5 is operatively connected to be rotated by the engine in any suitable manner, for example by being bolted to a suitable driving member therefor. The drive flange 5 is keyed to the central member 11 extending through the central part of the pump and is connected by a pin 15 to the lower end of the fuel distributor 4 which rotates the fuel distributor at the same speed as the drive flange 5.

A fuel pick-up pump 2 is provided at the opposite end of the preferred embodiment and may comprise the usual gear pump with an inner fixed gear member 16 (Fig. 2) attached by a stub shaft 17 in the end 18 of the pump which is bolted in position on the casing 1. An outer rotary member 19 has a depending stub shaft 20 (Fig. 3) which fits into the rotary fuel distributor 4 and has a squared portion 21 interlocked with a suitable recess in the fuel distributor. In this way, the pick-up pump is driven by the fuel distributor and receives fuel from the inlet 22, connecting with the conduit 24 leading to the intake side of the pump. The outlet side of the pump delivers to the conduit 9 which leads to the metering valve 7.

When the outer member 19 of the pick-up pump is rotated about the inner member 16, fuel is forced by the gear teeth into the outlet conduit for the pump and through the metering valve 7 in the usual manner with respect to pumps of this general type. It will be understood that any desired form of pump may be utilized but in the preferred embodiment the pick-up pump is mounted at one end of the main pump and operatively connected to be driven by the fuel distributor.

The construction of the fuel distributor may be observed best in Figs. 2, 3, 5 and 6. The rotary distributor member 4 fits into a suitable chamber 25, the upper end having a recess which receives and mounts the shaft 20 of the pick-up pump. The lower end of the rotary distributor 4 has an enlarged flangelike portion 26 thereon which lies against a flat surface 27. The member 4 is held in position by means of a coiled spring 28 engaging the flange member 26 and the upper side of the cam actuated member 10. The connecting pin 15 extends into a recess 29 of the flange 26 and into a recess 30 in the upper end of the rotary member 11 so that the distributor is operatively connected to rotate with the rotary member 11 and the drive member 5 keyed to the end thereof. Thus the distributor 4 rotates at a speed determined by the speed of the engine on which the pump is mounted. The purpose of the distributor is to operatively connect the cylinders of an internal combustion engine one at a time with the piston pump 6 for delivering fuel to the cylinders. The rotary distributor must also connect the piston pump with the fuel supply, in this instance the conduit 9 leading from the pick-up pump 2 past the metering valve 7, after each cylinder charging operation.

Referring more particularly to Fig. 5, it will be noted that the chamber wall surrounding the distributor 4 has a series of conduits 31 corresponding to the number of cylinders in the engine to be fueled. Preferably these conduits have threaded enlargements 32 for convenience in securing conduits leading to the engine cylinders. A suitable attachment for this purpose is illustrated at 33 in Fig. 2. The distributor 4 has a channel 34 in the outer surface thereof extending longitudinally of the distributor. This channel has sufficient length as shown more particularly in Figs. 2 and 3 to connect with the conduits 31 at one end and to connect at the other end thereof with the conduits 35 extending radially through the fuel distributor. These radial conduits 35 connect with the chamber above the piston pump 6 and also with the metering valve 7.

As the distributor 4 rotates, the channel 34 connects consecutively with the conduits 31 and is in communication with one of the conduits 35 at all times leading to the chamber above the piston pump 6. Thus the piston pump 6 may force fuel into the cylinders of the internal combustion engine whenever the channel 34 is in communication with one of the outlets 31 (Figs. 2 and 5). It will be noted in Fig. 5 that the channel 34 does not register with any of the conduits 31 at the time that the conduits 35 are in registry with the outlet from the metering valve 7. Conversely, when the channel 34 is in registry with the outlet conduits 31 to the engine cylinders, the connection to the metering valve is closed so that the full effect of the piston pump is utilized in forcing fuel into the engine cylinders without tending to force it back through the metering valve. In this way very high pressures may be obtained in the injection of fuel into the engine and into the cylinders. In addition, very accurate measurement of the amount of fuel delivered to each cylinder and uniform charges may be obtained. By having six inlets to the piston pump through the fuel distributor, one for each cylinder, the path of the fuel from the metering valve to the piston pump is always the same, thereby minimizing any variations in the amount of charge received by the respective cylinders. If the length of the path varied, the difference in resistance to the flow of the liquid might affect the uniformity of the charges.

In order to inject fuel into the engine cylinders in the proper amount, it is desirable that the piston pump 6 be moved a predetermined distance to inject the fuel. For this purpose, the lower end of the piston 6 is in contact with an actuator 10 which moves over the cam 36 having lobes 37 thereon. The actuator 10 likewise has lobes 38 thereon. Since the actuator 10 rotates with the member 11, the lobes 37 and 38 have to pass each other and in doing so the actuator 10 must rise as shown more particularly in Fig. 9. This causes the actuator to engage the lower end of the piston 6 and raise it upwardly to force the fuel in the chamber above the upper end thereof into the engine cylinder, which is connected with the chamber through the channel 34. It will be noted that the lower end of the piston 6 is not attached to the actuator 10 and hence the movement of the piston toward the cam is determined by the pressure of the fuel on the opposite end thereof.

Therefore, the amount of fuel delivered is determined by the position of the metering valve 7. Preferably the two ends of the piston 6 are similarly shaped so that either end may be inserted in the chamber to avoid errors in assembly, and both ends are likewise preferably shaped so that there will be no adherence between the actuator and the end of the piston in engagement therewith. As illustrated in the preferred embodiment, the ends are rounded. However, the ends may be hollowed as shown in Fig. 11 but the surface contact should be small to prevent suction or other adherence between the two parts.

Likewise it is desirable that the piston 6 be held near its extreme injecting position for a short period of time rather than to be immediately released after its extreme position has been reached. For this purpose the lobes on one of the members, preferably the lower member 36, are shown truncated at 39 (Fig. 9). In addition, the upper surface 39 is preferably inclined rearwardly. An angle of five degrees has been found to give good results. In this manner the piston 6 is moved to inject the fuel and is held near its extreme position for an instant, until the conduit to the engine cylinder is closed by the distributor. The angle of the truncated portion determines the line pressure relief to give a sharp cut off and to prevent so called "drip."

By having a series of six lobes, one for each engine cylinder, the actuator 10 is forced simultaneously at the six points about its periphery against the piston 6. The surfaces being well oiled, smooth operation results.

The inlet conduit 24 for the pick-up pump may be extended down to connect with suitable oil collector channels 40 at the upper surface of the flange 26 and 41 in the chamber for the piston 6. Longitudinal oil channels 40a in the surface of the distributor connect with the channel 41 to assure adequate lubrication. These channels tend to collect the oil which may pass the joints; hence, sufficient clearance may be allowed for lubrication and continuous operation without loss of oil. If desired the inlet conduit 24 may be connected as shown in Fig. 11 to cool the lower flange 26 of the distributor and to provide maximum lubrication for the upper surface thereof which operates under high pressures during the injection periods.

While the metering valve 7 determines the amount of fuel which is delivered to the chamber above the piston 6, it is desirable to limit the length of the stroke of the piston 6. In this way the maximum amount of fuel delivered can be controlled by the piston adjustment. To achieve this objective, a rod 42 extends through a central bore 44 in the rotating member 11 with one end 45 located centrally of the actuator 10 thereby to limit the downward movement of this member and in turn the downward movement of the piston 6. The other end of the rod 42 is threaded into the end of the member 11 as shown at 45 with the extreme end thereof shaped with a channel 46 or in any other suitable manner to permit rotation thereof by means of a wrench or similar tool. A suitable locknut 47 locks the rod in adjusted position. In this manner the position of the rod and the lower limit of the piston 6 may be adjusted as desired from the exterior of the pump to limit the maximum charge delivered regardless of the position of the metering valve. Thus waste of fuel and overcharging of the cylinders are avoided.

Any suitable metering valve may be utilized for controlling the amount of fuel fed to the distributor 4. As herein illustrated, a chamber 48, preferably cylindrical, is provided in the casing or base 1. A cylindrical member 49 extends into the chamber and has a slot 50 extending longitudinally thereof adapted to register with the end of the conduit 9 upon rotation of the cylindrical member 49. A suitable channel may be provided at 51 to collect any escaping fuel. A bushing 53 may extend about the member 49 if desired.

The free end of the cylindrical member 49 has fixed thereon a cross-arm 52 by means of a nut 54. One side 55 of the cross-arm has a flange thereon operatively connected to one end of a member 56. The other end of the member 56 is connected to a lever 57. The lever 57 is pivoted on the rod 58 and operatively connected at its other end to a sleeve 59 on the central member 11. The sleeve 59 is operatively connected to the governor weights 60 so that the metering valve is operatively connected to the governor weights by means of the sleeve 59, lever 57, link or member 56 and the cross-arm 52. In this manner the metering valve is controlled by the engine governor.

It will be understood that in certain instances the engine may be operated without a governor, for example in the operation of trucks where the operator regulates the speed as desired. In such instances, the metering valve may be operatively connected to a suitable accelerator in any desired manner.

In the preferred embodiment, the speed change is achieved by means of the arm 61 on a rod 62 having an arm 63 (Figs. 1, 2 and 3) thereon which is operatively connected to a suitable accelerator, lever or arm for speed adjustment. A spring 64 is connected at one end to the arm 61 and at its opposite end to the lever 57, as shown at 65. Preferably this connection of the spring to the lever 57 is by means of a slot 66 so that the effective tension of the spring may be varied by changing the position of the connection along the slot 66. In other words, the same spring may be utilized for different installations and where a stronger or weaker spring is required, the same effect may be obtained by changing the leverage of the spring with respect to the pivot 58 of the lever 57. This adjustment offers a substantial convenience in many instances, and is preferably made by means of a leaf spring 63 which serves as an idling control when the tension in spring 64 is relieved and which is held in position by a screw 63' extending through the end thereof (Fig. 4). When the rod 62 and the arm 61 are operated through a suitable speed adjustment member or accelerator to apply a pre-determined tension in the spring 64, this tension becomes effective in opposition to the movement of the sleeve 59 under the influence of the governor weights 60; hence, the speed of the engine will increase or decrease until the centrifugal force of the governor weights balances the tension in the spring 64 to feed fuel charges which will maintain that speed. The speed of the engine will thereafter remain substantially constant with either a uniform or variable load until the tension of the spring 64 is again changed for a different speed adjustment.

When it is desired to stop the engine, the accelerator may be moved to the stop position but preferably the accelerator is adjusted so that it can be moved only to an idling position. This permits manipulation of it without stopping the engine. It is desired generally to stop the engine by throwing a switch to cut off the electric current. This is achieved in the present embodiment by means of a magnet **14** (Figs. 2, 3 and 4) having an armature **68** held in its downward position by the energized magnet. The armature has a rod **69** extending upwardly therefrom through slots **70** in a bracket **71** and terminating below one end **72** of the cross-arm **52**. The rod **69** is urged toward the cross-arm **52** by means of a leaf spring **74** seated on the bracket **71** and fitting in a slot **75**. Thus when the current is cut off from the magnet **14**, the spring **74** urges the rod **69** upwardly into engagement with the cross-arm **52** to turn the metering valve **7** into its closed position; that is, into the position in which the slot **50** does not register with the conduit **9**. This stops the engine under normal conditions.

The member **56** connecting the opposite end of the cross-arm **52** to the metering valve is constructed to permit this closing of the valve independently of the governor. While a link or chain would serve this purpose, a preferred means is illustrated more particularly in Fig. 4, comprising a cylindrical member **76** with a spring **77** therein forced against the ball members **78** at each end. Hence, the member **56**, when pulled by the governor, is just as effective as a rigid link would be in operating the metering valve. On the other hand, when the metering valve is operated by de-energizing the electric magnet **14**, the member **56** will collapse with almost the same degree of ease that a string or chain would collapse. At the same time the parts are resiliently held in position to avoid any noise or lost motion. It is to be noted also that the lower end of the member **56** is threaded into the lever **57** so that the length of the member **56** may be adjusted as desired. In addition, the co-operating thread member is split as shown at **79** so that it may be locked in position by a set screw **80**. This adjustment permits the governor to be operated in its most effective position for normal speeds of the engine.

While any suitable lever may be utilized for operatively connecting the governor with the member **56**, the construction illustrated more particularly in Figs. 2, 3 and 7 is preferred. In this construction the lever **57** is pivoted about the rod **58** substantially at its center. The free end of the lever is operatively connected to the spring **64** and the link **56** as previously described. The opposite end is in the form of a fork **81** (Fig. 7) with pins **82** engaging the sleeve **59**. The pins **82**, in addition to operatively connecting the lever to the sleeve, also prevent rotation of the sleeve without causing undue friction between the sleeve and the rotating member **11**. In other words, the pins **82** give a smoother force transfer from the sleeve to the parts leading to the metering valve.

While any suitable governor may be utilized, the preferred embodiment has distinct advantages. As illustrated more particularly in Figs. 2 and 3, the governor comprises a series of weights **60** housed in pockets **84** welded or otherwise secured to a member **85** keyed to the central rotating member **11**. Preferably a series of weights herein illustrated as six in number are utilized to minimize the effect of gravity occasioned by reason of the fact that the weights rotate about a horizontal axis. Each weight has a slot **86** on the inner face thereof near one end which receives a flange **87** on one end of the sleeve **59**. Thus as the member **11** rotates the governor weights, the centrifugal force causes the small ends of the weights to move outwardly about the opposite ends pivoted in the corners of the pockets **84**. This outward movement causes the slots **86** to move, carrying with them the flange **87** and the sleeve **59**. This longitudinal movement in turn is transmitted to the metering valve **7** through the lever **57**, link **56** and cross-arm **52**. As pointed out hereinbefore, the centrifugal force of the weights **60** is balanced against the tension of the spring **64** and when the two forces are equal, equilibrium is reached and the speed of the engine fixed.

The parts are held together about the central member **11** by means of a large nut **88** and washer **89** at the lower end of the member. A suitable connection **90** may be provided for lubricating the rotating parts. The connection **90** connects with the space about the rod **42** and through the conduit **90*a*** (Fig. 2) in the enlarged end of the rod **42** with the space intermediate the surface of the cam **36** and the actuator **10**. The excess lubricating oil passes through the outlets **117** back to the crank case. Thus the various parts are thoroughly lubricated.

In order to avoid excessive pressures in the fuel line as a result of the pick-up pump **2**, it is desirable to have a relief valve. While any suitable relief valve may be utilized for this purpose, a preferred embodiment is illustrated more particularly in Figs. 2, 3 and 10. An outer casing **92**, substantially cylindrical, is threaded at one end as shown at **94** for fitting into the threaded connection **95** in the base or casing **1** and threaded at the other end as shown at **96** to permit the attachment of a suitable pipe which may be connected to the fuel tank or to the fuel line. The opening **95** in the base is directly above the conduit **9** so that the relief valve is subjected to the pressure in the fuel outlet from the pick-up pump leading to the metering valve **7**. A suitable chamber **97** is formed within the casing **92** and has an annular recess **98**. Within the chamber is mounted a cylindrical plunger **99** having a reduced end **100** adapted to fit against a depression in one side of the conduit **9** which limits the movement of the plunger in that direction. The plunger is normally forced toward this position by means of a spring **101** fitting back of it and seated in the casing **92**. When in the position shown, the plunger covers the annular recess **98** and prevents any passage of fuel through the relief valve. When the pressure in the fuel conduit **9** over-balances the pressure applied to the plunger **99** by means of the spring **101**, the plunger moves back uncovering the recess **98**. Fuel then escapes into the recess **98** through the central bore **104** and thence through the outlet end **105** of the relief valve. An advantage of this preferred embodiment of relief valve is that the spring **101** is constantly applying pressure to the plunger which in turn applies a pressure to the fuel in the conduit **9**. When the fuel distributor **4** permits fuel to flow from the metering valve into the chamber above the piston **6** the pressure, of course, drops in the fuel line. The piston therefore moves inwardly under the influence of the spring **101**. In so doing, it tends to increase the pressure in the fuel line. In this way the relief valve, in addition to relieving excess pressure, tends to maintain a constant pressure within the fuel line and tends also to give a smoother operation and a more accurate and uniform feed to the respective cylinders.

As described above, the adjustable rod **42** may be utilized to limit the downward movement of the cam actuated member **10** and the piston **6** and thereby limit the maximum amount of fuel which may be delivered to a cylinder in the engine. This maximum amount, however, would be the same regardless of the speed of the engine. If the metering valve should be opened sufficiently wide to permit a greater amount to be fed, the limitation on the downward movement of the piston 6 would prevent it. This prevents an excess amount of fuel being delivered to the engine when the metering valve is opened too far.

In many cases, optimum results may be obtained by limiting the maximum amount of fuel which may be delivered to the cylinder at varying speeds. A preferred embodiment which will achieve this result is illustrated in Fig. 11. A rod 42*a* is mounted in the upper end of the rotating member 11 having a pin 106 resting upon a cam surface 107 on the member 108. The member 108 extends transversely through the member 11*a* and has a spring 109 held in position by a nut 110 which tends to force the member 108 to the left as shown in Fig. 11. A weight 111 is mounted on the opposite end which exerts a centrifugal force, depending upon the speed of the engine, tending to compress the spring 109. As the speed of the engine increases, the pin 106 rides up on the inclined surface 107 and raises the rod 42*a* which limits the downward movement of the cam actuated member 10 and the piston 6*a*. The rod 42*a* is held in the position where the pin 106 is in engagement with the cam surface by means of a spring 112 effective upon a flange 114 on the rod 42*a* and is held in position by a threaded plug 115. In this way the delivery of an excess of fuel to the engine cylinders may be avoided. This minimizes smoke and fuel waste. For example, in the operation of trucks, where it is desired to have the truck maintain its speed in going up a hill, there is a limit to the amount of fuel which the engine can properly use. Any excess is wasted. If the load is too heavy, the speed of the engine will decrease. Under those circumstances, the spring 109 becomes effective to lower the member 42*a* to increase the amount of fuel fed to carry the extra load but limits the amount of fuel to that which the engine can consume at the particular speed. At high speeds less fuel can be consumed and a shorter stroke is imposed on the piston 6*a*.

A remarkable property of the present pump is that the volume of the individual charges decreases at high speeds without the automatic control described above. This is very desirable as the engine can consume larger charges at low speeds than at high speeds. This enables the pump to be operated at high speeds without an automatic control, and the pump is shown in Figs. 1 to 10 without the automatic control shown in Fig. 11. Extended tests have demonstrated this operating characteristic but the exact theory of operation is not yet known with certainty.

Another feature of the construction shown in Fig. 11 is the path of the incoming fuel. The inlet conduit 24*a* follows a substantially L-shaped path. The conduit 24*a* extends first toward the flange 26 of the distributor and forms a channel 24*b* over the face of it. A conduit 24*c* leads from the opposite side of the channel to the intake of the pick-up pump. The oil channel 40*a* is preferably eccentric with respect to the distributor axis to further increase the lubrication. This construction has several advantages. First it affords maximum lubrication between the flange 26 and the casing 1. This flange surface is subjected to substantially the full piston thrust during the charging operation by reason of the hydraulic pressure on the wall of the fuel chamber above the piston 6. Maximum lubrication is desirable for rotation while subjected to such high pressures. Second, the flow of the incoming oil over the surface of the flange 26 cools the flange in addition to lubricating it, thus minimizing expansion of the distributor resulting from increases in temperatures, thereby permitting a closer fit between the distributor and the surrounding casing.

The piston 6*a* is illustrated with hollow ends as an alternate to the form illustrated in the preferred embodiment. An oil trap or drain 116 is shown for receiving the oil which drains out of the pump through the apertures 117. This may consist of an ordinary plate 118 bolted to the base of the pump as illustrated. The remaining parts of the embodiment illustrated in Fig. 11 are substantially the same as in the preferred embodiment and further description is not necessary.

In the operation of the pump, the base 1 is bolted to a suitable support on or near the engine, and the driving member 5 is operatively connected to be driven by the engine. The driving member 5 thereupon rotates the central member 11 which is operatively connected to the distributor 4 by means of a pin 15. The rotation of the distributor, in addition to connecting the respective cylinders of the engine with the fuel metering valve, also rotates the inner member of the pick-up pump 2. Thus the pump 2, herein referred to generally as a pick-up pump, draws fuel from the fuel tank and pumps it to the metering valve 7 under substantial pressure through the conduit 9. The metering valve delivers the fuel to the chamber above the piston 6. At the time of the delivery to this chamber the distributor channel 34 leading to the engine cylinders is not in registry with any cylinder; hence, no fuel is fed to the cylinders at that time. As the distributor continues to rotate, the metering valve is shut off from the chamber above the piston 6 and this chamber is connected to an engine cylinder through the channel 34. The cam actuator 10 is then raised by being rotated over the cam lobes on the member 36 so that the piston 6 is raised to inject fuel into an engine cylinder. Thereafter the actuator 10 is returned by spring 28, leaving the piston 6 free to drop to its lower position. The piston follows the actuator a short distance under the line pressure until the distributor discharge part closes. Suction will retain it in this position (shown in Fig. 3) until the distributor moves to a point where the chamber above the piston is connected with the metering valve, and the pressure of the incoming fuel pushes the piston toward its retracted position a distance depending upon the amount of fuel permitted to enter by the metering valve.

While the metering valve may be controlled manually in certain installations, for example on trucks where variable speeds are incident to the operation, in many installations a substantially constant but adjustable speed is required. A governor is provided in the preferred embodiment comprising a series of weights 60 housed in pockets 84 and effective upon the sleeve 59. As the weights rotate they are thrown outwardly to slide the sleeve. The sleeve 59 is in turn operatively connected to the metering valve through the lever 57 pivoted at 58, member 56 and cross-arm 52 on the metering valve. A suitable spring 64 is also connected to the lever 57 at one end and to an arm 61 at the other. The tension in this spring operates in opposition to the force applied by the governor and the speed of the engine becomes substantially constant when the forces created by the tension of the spring and by the governor are the same, and the amount of fuel being delivered is sufficient to maintain that speed. If the load increases the amount of fuel fed automatically increases and vice versa.

In order to obtain adjustable speeds, the arm 61 may be connected through the rod 62 and arm 63 to any suitable accelerator so that the tension of the spring may be increased or decreased to increase or decrease the speed of the engine. In each instance a balanced condition eventually prevails which determines the speed of the engine. The pump is suitable for either variable loads at constant speeds or variable loads at variable speeds.

The engine may be stopped at any time independently of the governor by throwing a switch which breaks the current passing through the magnet 14. This permits the spring 74 (Fig. 3) to raise the rod 69 into engagement with one side of the cross-arm 52 on the metering valve. This in turn closes the metering valve by collapsing the member 56 regardless of the position of the governor.

The relief valve illustrated more particularly in Figs. 2 and 10 not only relieves any excess pressure in the fuel line but also tends to maintain a constant pressure therein by reason of the fact that the resiliently mounted plunger builds up pressure in the fuel line at the time the metering valve is connected to the charging chamber causing a drop in pressure.

In assembling and testing the pumps, the cam 36 is adjusted by means of the bolt 13 in the slot 43 so that the injection is properly timed with respect to the opening and closing of distributor parts 32 leading to the engine cylinders. This adjustment determines the amount of fuel that can be returned from the conduits leading to the engine cylinders prior to the closing of the part by the distributor. The latter is controlled by the position of the cam at the time the part closes. The pump may be timed with respect to the engine by suitable adjustments between the drive therefor and the driving flange 5 so that injection of fuel into the engine cylinders is at the proper time.

It will be seen that the present invention provides a simple and effective means for pumping fuel to engine cylinders. The construction is inexpensive, simple, compact and unitary. The several parts and mechanisms, including the pick-up pump and the governor, are all in a common housing. This simplifies the construction, reduces the number of parts and minimizes the cost. The pick-up pump, the cam for the piston pump, the distributor and the governor all rotate about substantially the same axis and are driven by the same means. The preferred embodiment of the governor and its connection to the metering valve has distinct advantages over prior structures. The relief valve, in addition to relieving excess pressures, tends to maintain a constant pressure. The parts are self-lubricating and the seepage between various parts is collected and delivered back to the fuel line. The parts are rugged in construction and fully capable of withstanding the rough usage to which they may be subjected.

As various changes may be made in the form, construction and arrangement of the parts herein without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. In a fuel pump for internal combustion engines and the like, the combination of rotary means, including a fuel distributor, extending longitudinally of the fuel pump, a pick-up pump operatively connected to said rotary means and driven thereby, a conduit connecting the pick-up pump to the fuel distributor, a governor mounted on said rotary means and devices responsive to the governor for controlling the fuel delivered through said conduit to said fuel distributor.

2. In a fuel pump for internal combustion engines and the like, the combination of rotary means, including a fuel distributor, extending longitudinally of the fuel pump, a pick-up pump operatively connected to said rotary means and driven thereby, a piston charging pump forming a part of the fuel distributor, a cam driven by said rotary means for operating said piston pump, a conduit connecting the pick-up pump to the fuel distributor, a governor mounted on said rotary means and devices responsive to the governor for controlling the fuel delivered through said conduit to said fuel distributor.

3. In a fuel pump for internal combustion engines and the like, the combination of a fuel distributor extending longitudinally of the fuel pump and rotatably mounted therein, a pick-up pump operatively connected to said distributor and driven thereby, a piston charging pump comprising a piston freely mounted in said distributor, a cam effective for operating said piston pump upon rotation of the distributor, a conduit connecting the pick-up pump to the fuel distributor, a governor mounted for rotation with said distributor, and devices responsive to the governor for controlling the fuel delivered through said conduit to said fuel distributor.

4. In a fuel pump for internal combustion engines and the like, the combination of rotary means, including a fuel distributor, extending longitudinally of the fuel pump, a pick-up pump operatively connected to said rotary means and driven thereby, a piston charging pump forming a part of the distributor including a freely mounted piston adapted to be moved in one direction by the entering fuel charge, means for periodically moving said piston in an opposite direction upon rotation of said rotary means, a conduit connecting the pick-up pump to the piston charging pump, means including a metering valve for controlling the flow of fuel through said conduit, and means for actuating the metering valve responsive to the speed at which said rotary means is driven.

5. In a fuel pump for internal combustion engines and the like, the combination of rotary means, including a fuel distributor, extending longitudinally of the fuel pump, a pick-up pump operatively connected to said rotary means and driven thereby, a piston charging pump forming a part of the fuel distributor, a cam driven by said rotary means for operating said piston pump, adjustable means for limiting the effect of said cam and the maximum stroke of said piston, a conduit connecting the pick-up pump to the fuel

distributor, a governor mounted on said rotary means and devices responsive to the governor for controlling the fuel delivered through said conduit to said fuel distributor.

6. In a fuel pump for internal combustion engines and the like, the combination of rotary means, including a fuel distributor, extending longitudinally of the fuel pump, a pick-up pump operatively connected to said rotary means and driven thereby, a piston charging pump forming a part of the fuel distributor, a cam driven by said rotary means for operating said piston pump, a rod extending axially of asid rotary means for limiting the effect of said cam and the maximum stroke of said piston, said rod being adjustable in position from the exterior of the fuel pump, and a conduit connecting the pick-up pump to the fuel distributor.

7. In a fuel pump for internal combustion engines and the like, the combination of a casing, rotary means including a fuel distributor in the casing, a pick-up pump at one end of said casing and operatively connected to said rotary means and driven thereby, a single piston charging pump forming part of said fuel distributor, a cam forming a part of said rotary means for operating said piston pump, a conduit connecting the pick-up pump to the fuel distributor, governor weights mounted about said rotary means and driven thereby, and devices responsive to said governor weights for controlling the fuel delivered through said conduit to the distributor.

8. In a fuel pump for internal combustion engines and the like, the combination of a casing, rotary means including a fuel distributor in the casing, a pick-up pump at one end of said casing and operatively connected to said rotary means and driven thereby, a piston charging pump forming part of said fuel distributor, a cam forming a part of said rotary means for operating said piston pump, a conduit connecting the pick-up pump to the fuel distributor, governor weights mounted about said rotary means and driven thereby, devices responsive to said governor weights for controlling the fuel delivered through said conduit to the distributor, and electromagnetic means for superseding the action of the governor weights to stop the flow of fuel through said conduit.

9. In a fuel pump for internal combustion engines and the like, the combination of a pick-up pump having a rotary member, a fuel distributor, a piston pump for delivering fuel to the engine cylinders, a fuel conduit leading from said pick-up pump to said piston pump, a cam-like member rotatable about the axis of said distributor, means for periodically effecting reciprocatory movement of said cam-like member for operating said piston pump, and means adjustable from the outside of the fuel pump for varying the movement of said cam-like member and the stroke of said piston pump to limit the amount of fuel delivered thereby.

10. In a fuel pump for internal combustion engines and the like, the combination of a pick-up pump, a rotary fuel distributor, a piston pump for delivering fuel to engine cylinders, a fuel conduit leading from said pick-up pump to said piston pump, a cam-like member rotatable about the axis of said rotary distributor for operating said piston pump, and controlling means movable in accordance with rotation of said cam-like member for automatically limiting the stroke of the piston pump to control the maximum amount of fuel to be delivered by the piston pump at particular speeds.

11. In a fuel pump for internal combustion engines and the like, the combination of a pick-up pump, a rotary fuel distributor, a piston pump for delivering fuel to engine cylinders, a fuel conduit leading from said pick-up pump to said piston pump, a cam rotatable about the axis of said rotary distributor for operating said piston pump, and means centrifugally operated to automatically limit the stroke of the piston pump to control the maximum amount of fuel delivered by the piston pump at particular speeds.

12. In a fuel pump for internal combustion engines and the like, the combination of a pick-up pump having a rotary member, a rotary fuel distributor, operatively connected to drive said rotary member, a piston pump for delivering fuel for distribution by said fuel distributor, a fuel conduit leading from said pick-up pump to said fuel distributor and a relief valve operatively connected to said conduit comprising a chamber member having a recess in a wall thereof, a resiliently mounted plunger in said chamber extending over said recess in closed position and adapted to yield to uncover said recess to permit escape of excessive fuel when a predetermined pressure is reached and a portion extending from said plunger into said fuel conduit adapted to affect the flow of fuel therethrough.

13. In a fuel pump for internal combustion engines and the like, the combination of a pick-up pump having a rotary member, a rotary fuel distributor, operatively connected to drive said rotary member, a piston pump for delivering fuel for distribution by said fuel distributor, a conduit leading from said pick-up pump to said fuel distributor and a relief valve operatively connected to said conduit comprising a chamber having a recess in the side thereof, a reciprocable plunger to cover and uncover said recess, resilient means effective upon said plunger to force it to a position covering said recess, the fuel under pressure in said conduit being effective to force said plunger in a direction opposing said resilient means, to uncover said recess, whereby said plunger in addition to relieving excess pressure in said fuel conduit tends to maintain a more uniform pressure therein.

14. In a fuel pump for internal combustion engines and the like, the combination of a rotary distributor fixed against longitudinal movement, a pump for delivering fuel to be distributed by said distributor including a piston extending into said distributor, means for delivering fuel to said pump, a rotatable member operatively connected to the piston for reciprocating the piston when the member is reciprocated, means for reciprocating the member operable when the member is rotated, rotatable driving means, and means forming a driving connection between said driving means and the distributor and the rotatable member, said last named means being constructed and arranged to permit axial movement of the rotatable member relative to the distributor and the driving means.

15. In a fuel pump for internal combustion engines and the like, the combination of a rotary distributor fixed against longitudinal movement, a pump for delivering fuel to be distributed by said distributor including a piston extending into said distributor, means for delivering fuel to said pump, a rotatable member operatively connected to the piston for reciprocating the piston when the member is reciprocated, means for recipro-

cating the member operable when the member is rotated, rotatable driving means, and means forming a driving connection between the driving means and the distributor and the rotatable member and for permitting reciprocating motion of the rotatable member relative to the distributor and the driving means comprising a pin extending between the driving means and the distributor through the rotatable member.

16. In a fuel pump for internal combustion engines and the like, the combination of a rotary distributor fixed against longitudinal movement, a pump for delivering fuel to be distributed by said distributor including a piston extending into said distributor, means for delivering fuel to said pump, and means for reciprocating the piston comprising a fixed cam having a plurality of annularly arranged lobes, an actuating member for said piston and operatively connected thereto having a corresponding number of lobes for cooperating with the lobes of said cams, means urging said cam and actuating member toward each other to maintain said cooperating lobes in operative position, and means for rotating the actuator member.

17. In a fuel pump for internal combustion engines and the like, the combination of a rotary distributor fixed against longitudinal movement, a pump for delivering fuel to be distributed by said distributor including a piston extending into said distributor, means for delivering fuel to said pump, a fixed cam member having a plurality of concentrically arranged lobes generally triangular in section, an actuator member for said piston and operatively connected thereto having a corresponding number of lobes generally triangular in section on a complementary surface thereof for cooperating with the lobes of said cam, the lobes of one of said members being truncated, and means for rotating the actuator member.

18. In a fuel pump for internal combustion engines and the like, the combination of a rotary distributor fixed against longitudinal movement, a pump for delivering fuel to be distributed by said distributor including a piston extending into said distributor, means for delivering fuel to said pump, a fixed cam having a plurality of concentrically arranged lobes, an actuator member for reciprocating said piston and operatively connected thereto having a corresponding number of lobes on a complementary surface for cooperating with the lobes of said cam, means normally urging the actuator toward said cam, means for rotating the actuator, and means operable from the exterior of the fuel pump and extending actually of the cam for selectively limiting the extent of movement of the actuator member toward the cam.

19. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor mounted axially of and driven by said rotary means, means including a metering valve for delivering fuel to said distributor, a governor mounted on said rotary means, and means responsive to said governor for operating said metering valve.

20. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor including a piston charging pump mounted axially of and driven by said rotary means, a fuel pick-up pump, means including a metering valve for delivering fuel from said pick-up pump to said distributor, a governor mounted on said rotary means, and means responsive to said governor for operating said metering valve.

21. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor mounted axially of and driven by said rotary means, means including a metering valve for delivering fuel to said distributor, a governor mounted on said rotary means having a plurality of pivotally mounted weights, a sleeve slidable axially of said rotary means and operatively connected to said governor weights to be moved thereby, and means responsive to the axial movement of said sleeve and operatively connected to said metering valve to control the valve responsively to the movement of the sleeve.

22. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor mounted axially of and driven by said rotary means, means including a metering valve for delivering fuel to said distributor, a plurality of pockets mounted on said rotary means having weights pivotally mounted therein, a sleeve slidable axially of said rotary means and operatively connected to said weights to be moved thereby, and means responsive to the axial movement of said sleeve and operatively connected to said metering valve to control the valve responsive to the movement of the sleeve.

23. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor driven by said rotary means, means including a metering valve for delivering fuel to be distributed by said distributor, means slidable axially of said rotary means, governor weights operatively connected to said slidable means, means for connecting said slidable means to said metering valve, resilient means operatively connected to said slidable means, and means operatively connected to said resilient means for adjustment thereof.

24. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor driven by said rotary means, means including a metering valve for delivering fuel to be distributed by said distributor, means slidable axially of said rotary means, governor weights operatively connected to said slidable means, and collapsible means for connecting said slidable means to said metering valve, whereby said collapsible means may be collapsed independently of the position of said slidable means.

25. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor driven by said rotary means, means including a metering valve for delivering fuel to be distributed by said distributor, means slidable axially of said rotary means, governor weights operatively connected to said slidable means, collapsible means for connecting said slidable means to said metering valve, whereby said collapsible means may be collapsed independently of the position of said slidable means, and electrical means for closing said metering valve by collapsing said collapsible means.

26. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor driven by said rotary means, means including a metering valve for delivering fuel to be distributed by said distributor, means slidable

axially of said rotary means, governor weights operatively connected to said slidable means, resilient means operatively connected to said slidable means, means operatively connected to said resilient means for engine speed adjustment, and means for connecting said slidable means to said metering valve, including a member operatively connected to said slidable means to prevent rotation thereof.

27. In a fuel pump for internal combustion engines and the like, the combination of rotary means extending axially of the pump, a fuel distributor driven by said rotary means, means including a metering valve for delivering fuel to be distributed by said distributor, means slidable axially of said rotary means, governor weights operatively connected to said slidable means, means for connecting said slidable means to said metering valve, resilient means comprising a spring arm operatively connected to said slidable means, and means for varying the effective length of said spring arm for engine speed adjustment.

28. In a fuel pump for internal combustion engines and the like, the combination of a fuel valve for controlling the fuel delivered to the pump, a governor for controlling said fuel valve, collapsible means for connecting said governor to said fuel valve, and electromagnetic means for closing said fuel valve independently of the action of the governor by collapsing said collapsible means.

29. In a fuel pump for internal combustion engines and the like, the combination of a housing provided with a plurality of fuel discharge conduits, a rotary pick-up pump in said housing, a single rotary fuel distributor for delivering fuel to each of said plurality of fuel discharge conduits, a single reciprocable piston for forcing fuel through said fuel discharge conduits to engine cylinders, a fuel conduit connecting said rotary pick-up pump with said reciprocable piston, a cam, means for reciprocating said piston upon relative rotation between said cam and said means, and a spring yieldably maintaining said cam and said means in operative relationship.

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