May 27, 1969 A. O. SIMKO 3,446,198

INTEGRATED FUEL INJECTION AND IGNITION DISTRIBUTOR ASSEMBLY

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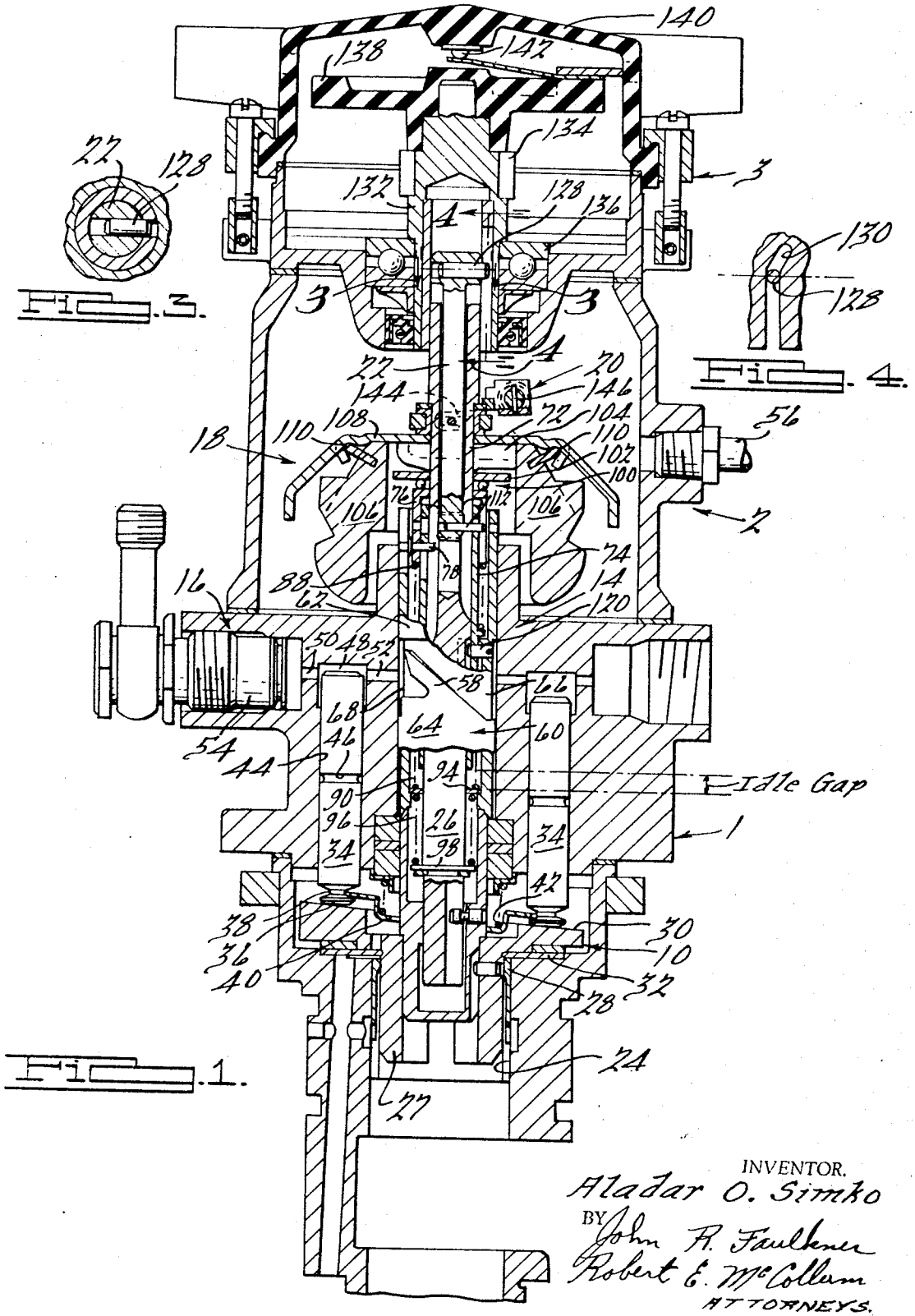


Fig. 3.

Fig. 4.

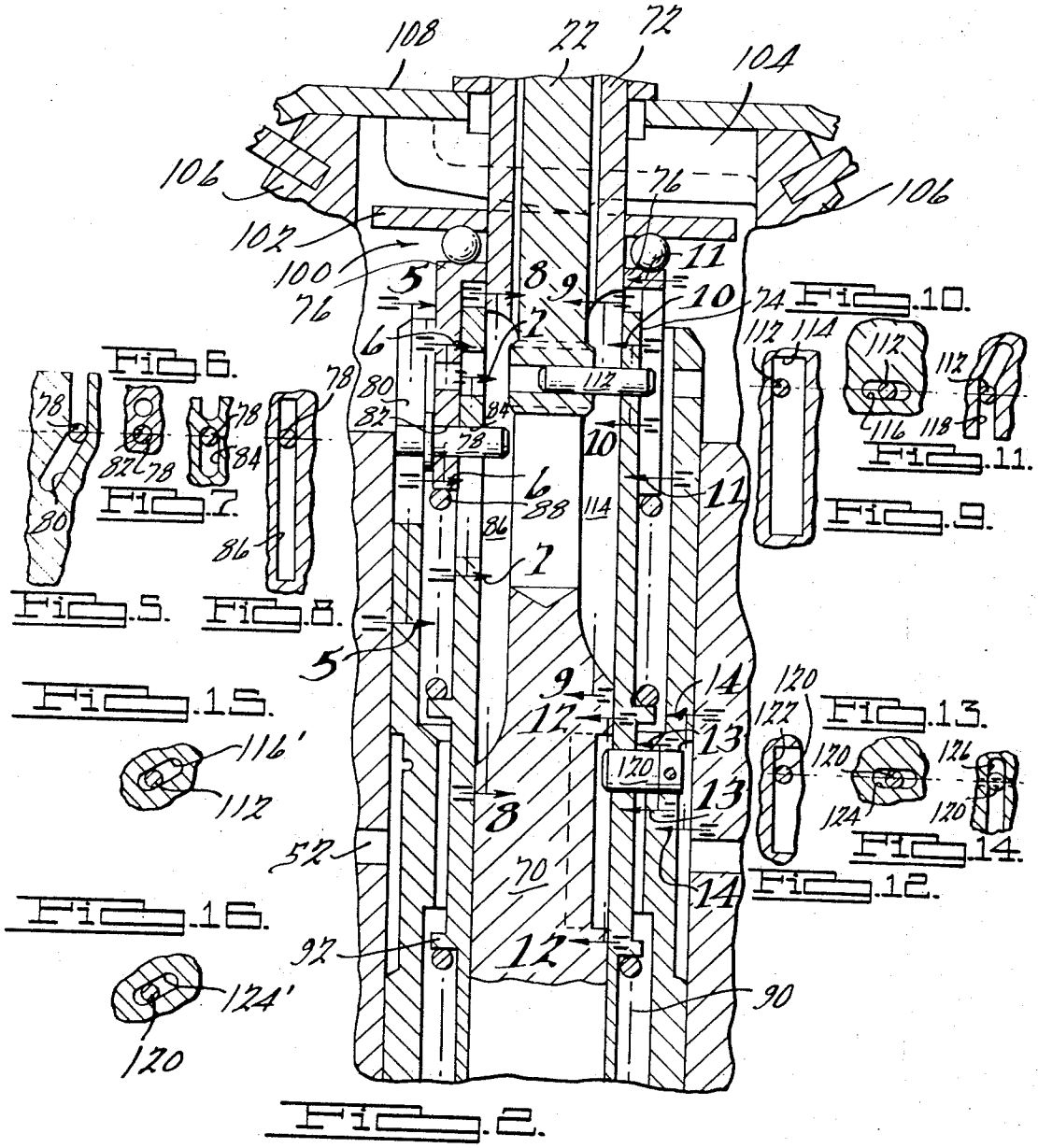
Fig. 1.

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INTEGRATED FUEL INJECTION AND IGNITION DISTRIBUTOR ASSEMBLY

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ABSTRACT OF THE DISCLOSURE

An internal combustion engine fuel injection pump and an ignition distributor are integrated into a single unit with a common mechanical governor simultaneously controlling changes in fuel flow and spark advance as a function of engine speed changes. Additionally, the engine throttle lever is connected to the assembly in a manner to simultaneously also control spark advance changes and fuel flow changes as a function of the load as indicated by changes in the position of the conventional engine accelerator pedal. The pump is of the central feed type, with a fuel flow control sleeve surrounding the pump and rotatable with it and also relative to it. The distributor is of the centrifugal advance type. The pump and distributor have a common driveshaft that is axially movable in one direction by the vehicle accelerator pedal, and the metering sleeve is movable in the opposite direction relative to the driveshaft, to vary fuel flow and spark advance changes.

This invention relates, in general, to an internal combustion engine of the spark ignition type utilizing injection of fuel directly into the engine combustion chambers. More particularly, the invention relates to the integration of a fuel injection pump assembly and an ignition distributor into a single unit with common controls.

Reliable operation of an engine utilizing direct injection of fuel depends a great deal upon the correct timing of the injection and the spark. For this reason, it is very desirable to integrate the fuel injection pump and the ignition distributor into a common housing with a single governor and a control system that operates on both units. In the past, the ignition distributor generally was separated from the fuel injection pump, and separate speed responsive and other controls were necessary.

One of the objects of the invention, therefore, is to provide an integrated fuel pump and ignition distributor assembly having a single governor and a control system common to both units.

It is another object of the invention to provide an integrated assembly of the type described, and in which the ignition distributor is of the centrifugal advance type responsive to changes in speed of the pump drive shaft to automatically advance or retard the spark timing mechanism.

It is a still further object of the invention to provide an integrated pump and ignition distributor assembly in which both fuel injection advance and spark ignition advance or retard are provided automatically upon the attainment of a predetermined speed of rotation of the driveshaft, as modified by the load indicated by the position of the conventional engine throttle means.

Another object of the invention is to provide an integrated fuel injection pump-ignition distributor assembly in which the fuel pump is of the swash plate, central feed type having a fuel flow metering sleeve valve surrounding the driveshaft; the sleeve being axially and rotatably mounted relative the shaft to permit a variance in the fuel flow to the injection line with changes in speed as well as load; and, simultaneously, the ignition distributor spark advance mechanism is controlled to vary in accordance with load and/or speed changes.

Other objects, features and advantages of the invention will become apparent upon reference to the succeeding detailed description thereof, and to the drawings illustrating a preferred embodiment thereof, wherein:

FIGURE 1 is a cross-sectional view of one embodiment of an integrated fuel pump and ignition distributor assembly constructed according to the invention;

FIGURE 2 is an enlarged cross-sectional view of a portion of the FIGURE 1 showing;

FIGURES 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 are reduced size cross-sectional views taken on planes indicated by and viewed in the direction of the arrows **3—3**, **4—4**, **5—5**, **6—6**, **7—7**, **8—8**, **9—9**, **10—10**, **11—11**, **12—12**, **13—13** and **14—14**, respectively, of FIGURES 1 and 2; and

FIGURES 15 and 16 are cross-sectional views of modifications of the construction shown in FIGURES 10 and 13, respectively.

FIGURE 1, which is essentially to scale, shows an overall cross-sectional view of the integrated fuel pump and ignition distributor assembly. It includes a two-part lower housing portion **1** that encloses the drive mechanism **10** and plungers **12** for a swash plate type fuel pump, the lower portion of a fuel flow metering assembly **14**, and the injection line delivery valves and connectors **16**. The intermediate housing part **2** encloses a mechanical speed responsive governor **18** for controlling fuel injection flow and spark advance as a function of driveshaft or engine speed; an engine throttle lever or vehicle accelerator pedal linkage connection **20** to the driveshaft that provides fuel flow control and spark advance as a function of engine load as indicated by the axial position of the driveshaft; and the lower portion of the ignition distributor driveshaft **22**. The upper housing part **3** is constituted by an engine ignition distributor.

More specifically, lower housing portion **1** has a central stepped diameter bore **24** in which a driveshaft **26** is rotatably mounted. The lower portion of shaft **26** is axially slidably splined to a driving sleeve **27** that is rotatably mounted in the housing on side bearings **28**. The sleeve and shaft, in general, would be driven by a suitable power takeoff, not shown, from the engine crankshaft, at say one-half engine speed, for example. The upper part of sleeve **27** is formed integral with the drive plate **10** of a known type of swash plate pump having an angled drive surface **30**. Plate **10** is rotatably mounted on thrust bearings **32**.

The angled swash plate surface **30** cooperates with, in this case, eight (only two shown) reciprocating fuel pumping plungers **34** that are concentrically mounted with respect to the axis of driveshaft **26** and bore **10**. Each plunger **34** has a lower button-like end **36** that is held against the annular drive surface **30** by a disc-like plate **40** interconnecting all of the plungers. A suitable spring **42** biases the disc and thus the plungers against drive surface **30**.

Each of plungers **34** is axially slidably mounted in a sealing manner in a bore **44**. An annular groove **46** is provided for fuel leak-off and lubrication-sealing purposes. The upper end of each bore **44** is enlarged into a chamber **48** that is intersected by cross bores **50** and **52**.

Each of the bores **50** constitutes a passage for the discharge of fuel under pressure from the pump plunger chamber **48** past a conventional delivery valve **54**. The details of construction and operation of delivery valve **54** are not given since they are known and believed to be unnecessary for an understanding of the invention. Suffice it to say, that the delivery valves open at a predetermined

fuel pressure in passage **50** to supply fuel to the individual engine cylinder injection lines, and upon closing, retract a finite volume of fuel from the injection line to prevent after-dribbling or secondary injection. See U.S. Patent 3,319,568, for example.

Bores **52** constitute fuel spill and supply or fill holes or ports connected to the central bore **24**. The spill holes cooperate with the fuel flow metering assembly **14** movable in bore **24**, in a manner to be described, to control the pressure build up of fuel in plunger chambers **48**, and, therefore, the discharge of fuel from chamber **48** past delivery valve **54**.

Fuel normally is supplied to the center bore **24** from a supply line **56** and connecting passages, not shown, line **56** being supplied with fuel under pressure from a transfer pump, also not shown.

In general, each of the pump plungers **34** draws in fuel from bore **24** through its own spill hole **52** during the suction stroke of the plunger. During the plunger upstroke, fuel will be displaced either back into the central chamber defined by bore **24**, or will be forced past its delivery valve **54** and out through the injection nozzle, as a function of the position of the fuel flow metering valve assembly **14**.

Turning now to the fuel flow metering assembly, fuel flow is controlled by proper phasing of a rotating helix **58** that also is movable axially with respect to each of the spill holes **52** to variably close or open them for a greater length of time during one rotation of the driveshaft **26**. Helix **58** is part of a rotatable sleeve valve **60** of the spool type that has upper and lower lands **62** and **64** interconnected by a neck portion **66** of reduced diameter. The land diameters are such as to effectively seal the annular internal fuel reservoir or chamber **68** defined between the lands so that axial movement of the valve (and helix) can vary fuel flow.

Helix **58** is an extension of lower land **64**, and consists of a circumferentially extending portion raised radially with respect to neck portion **66**, and has a predetermined shape.

Fuel flow metering sleeve **60** surrounds and rotates with driveshaft **26**, and can be moved both axially and rotatably with respect to it, in a manner to be described. As best seen in FIGURE 2, driveshaft **26** has a solid lower portion **70** that extends upwardly slightly beyond the spill holes **52**, at which point the shaft is bored or hollowed out to a tubular portion **72**. This latter portion then extends upwardly into the ignition distributor.

Driveshaft **26** is radially spaced from metering sleeve valve **60** by a pair of additional flow control sleeves **74** and **76** that are concentrically mounted with respect to both driveshaft **26** and metering sleeve valve **60**. Sleeve **74** is a delivery control sleeve, and sleeve **76** is a speed advance control sleeve.

Driveshaft **26** and sleeve valve **60** are interconnected by a drive pin **78** (left side of FIGURE 2). The pin passes through and engages a cam follower slot **80** (FIGURE 5) in the metering shaft sleeve **60**; is pressed through an aperture **82** (FIGURE 6) in the speed advance sleeve **76**; passes through an axial slot **84** (FIGURE 7) in the delivery control sleeve **74**; and rides in a vertical slot **86** (FIGURE 8) in driveshaft **26**. The vertical slots in driveshaft **26** and delivery control sleeve **74** permit relative axial motion between speed advance sleeve **76** and delivery control sleeve **74** and the driveshaft, for a purpose to be described.

Speed advance sleeve **76** is yieldably separated from delivery control sleeve **74** by a preloaded spring **88**. Delivery control sleeve **74**, in turn, is biased upwardly by a preloaded idle speed control spring **90** located between a shoulder **92** on the delivery control sleeve **74** and a washer **94** (FIGURE 1) slidably mounted on the driveshaft **26**. The washer **94**, in turn, is urged upwardly by means of a preloaded overspeed spring **96** (FIGURE 1) seated between the washer and a stationary portion **98** of the housing.

Additional functions of drive pin **78** are to maintain the delivery control sleeve **74** phased with the rotation of driveshaft **26** and to maintain a preload on speed advance spring **88**.

Speed advance sleeve **76** rests against the lower portion of a ball bearing unit **100**, the upper portion of which is abutted by an axially slidable bearing plate **102** forming a part of governor mechanism **18**. Bearing against the top of bearing plate **102** on each side is a horizontally disposed arm portion **104** of a governor weight **106** that is hingedly mounted on an essentially rectangular mounting plate **108**. The plate **108** is fixedly secured for rotation with the upper driveshaft sleeve portion **72**. It will be clear that with increased engine speed, the outward displacement of weights **106** due to centrifugal force will rock them about the hinge-points **110** and cause the lever arms **104** to move the speed advance sleeve **76** downwardly relative to driveshaft **26**.

The sleeve-like upper portion **72** of driveshaft **26** rotatably receives within it the ignition distributor driveshaft **22**. This latter shaft is drivingly connected to shaft **26** by a pin **112** (see also FIGURE 2) that extends loosely (for both horizontal and vertical movements relative to it) through a slot **114** (FIGURE 9) in the driveshaft, through a horizontally elongated slot **116** (FIGURE 10) in the delivery control valve sleeve **74**, and through an angled cam follower type slot **118** (FIGURE 11) in speed advance sleeve **76**.

Further connections between the sleeve members includes a torque drive pin **120** that extends through a horizontally and vertically elongated slot **122** in driveshaft **26**, through a horizontally elongated slot **124** in the delivery control sleeve **74**, and is pressed through an aperture **126** in the metering shaft sleeve **60**.

Returning to FIGURE 1, the upper portion of the ignition distribution driveshaft **22** is press fitted with a drive pin **128** (FIGURES 3 and 4). The pin slides in an elongated cam follower type slot **130** (FIGURE 4) in a sleeve **132** on which is fixed the conventional distributor breaker point cam **134**. Sleeve **132** is rotatably mounted on a bearing race **136**, and has at its upper end a distributor rotor **138** of a known construction. The rotor successively engages the circumferentially spaced cylinder spark plug contacts **139** on the inside of distributor cap **140**, in a known manner, upon rotation of shaft **22**, to complete the circuit from the center coil contact **142** to the respective spark plug. The cap **140** is clamped to the housing portion **2** in the manner shown.

Distributor driveshaft **22** is pivotally connected by a lever **144** to a shaft **146** that is rotated by the engine throttle lever or accelerator pedal linkage (not shown). Opening movement of the throttle lever between an at rest or engine idle speed position and a wide-open throttle position will pivot shaft **146** clockwise to vertically raise the distributor driveshaft **22**. With the drive pin **112, 128** and **78** connections as described, this will also raise driveshaft **26**, governor assembly **18**, delivery control sleeve **74**, speed advance sleeve **76**, and the metering shaft sleeve **60**, as a unit.

OPERATION

Assume that the engine on which the fuel pump and ignition distributor assembly is installed is not running. The throttle lever **144** will be in the down or engine idle speed position due to the force of the accelerator pedal return spring (not shown); the lever, therefore, will not exert an upward pulling force on the distributor driveshaft at this time. Also, since the governor is in an inoperative position, no downward force is exerted on the sleeves. Therefore, the parts will be positioned as shown in FIGURE 1 due to the preload forces of overspeed spring **96**, idle speed spring **90**, and the fuel injection speed advance spring **88**. The forces of these springs would be so chosen, such as 20 lbs., 1 lb., and 4 lbs.,

respectively, for example, and the helix on the metering shaft sleeve so formed, as to position the apex of the helix at a particular point with relation to spill holes **52** so that if nothing else were done but the fuel pump mechanism now rotated, the small cross-sectional raised portion of the helix opposite the spill holes would block off the spill holes for only a short duration of one rotation of driveshaft **26**. During this short time, fuel pumped by plungers **34** into the bores **50** and **52** would be forced past delivery valve **54** and out into the injection nozzles so as to supply the desired amount of fuel to the engine at this time.

Therefore, the amount of fuel delivered to the engine at this time will vary as a function of the position of throttle pedal lever **144** (which raises the metering shaft sleeve **60** and helix **58** and thereby blocks the spill holes **52** for a longer period during any one rotation of the driveshaft **26**), and the outward position of the governor weights **106** (which exert a downward force through the speed advance spring **88** on delivery control sleeve **74** against idle speed spring **90** in an attempt to move delivery control sleeve **74** and thus metering shaft sleeve **60** downwardly to decrease the fuel supply through the delivery valves **54**).

More specifically, assume that a prime start of the engine is desired. The conventional accelerator pedal would be moved to or near to its wide-open position. This will rotate the throttle lever shaft **146** clockwise and pivot the lever **144** in the same direction to raise the lower distributor driveshaft portion **22** upwardly. This raises distributor drive pin **128** (FIGURE 1) vertically in slot **130** (FIGURE 4), which rotates the distributor breaker point cam **134** and sleeve **132** relative to shaft **22** to advance the spark its maximum or near maximum amount. Simultaneously, the raising of shaft **22** raises delivery control sleeve **74** through drive pin **112**, and metering shaft sleeve **60** through drive pin **120**. The raising of delivery control sleeve **74** also raises speed advance sleeve **76** and thereby governor mechanism **18**. The idle gap, which is the distance between the lower end of the delivery control sleeve **74** and the washer **94** on driveshaft **26**, and is shown in FIGURE 1, is now wide open, since there are no governor centrifugal forces acting against the spring preload.

Thus metering helix **58** (FIGURE 1) on the metering shaft sleeve **60** will be raised to a point where the spill holes **52** will be blocked for a maximum or near maximum period during any one rotation of driveshaft **26** and sleeve **60**. Pump plungers **34** will now be capable of pumping the maximum quantity of fuel out past the delivery valves **54** to the injection nozzles, when the engine is started.

Assume now that the engine has started, and the operator releases the accelerator pedal. Releasing throttle lever **144** now lowers the assembly **18** as a unit, and the governor will now attempt to establish an idle speed condition in a speed range of say 300–800 r.p.m. 550 r.p.m. would be the desired idle speed setting, for example. In this particular instance, the preload on the idle speed spring **88** is such that when the desired 550 r.p.m. idle speed is obtained, the idle gap will be approximately half of the axial length indicated in FIGURE 1. Stable idle speed operation will be assured by the governor action, which forces the metering sleeve helix **58** downwardly to cut down fuel delivery in case of speed increases above 550 r.p.m., or increases fuel delivery at speed decreases below 550 r.p.m. by axial repositioning of delivery control sleeve **74** and metering shaft sleeve **60**. Since the distributor driveshaft **22** is positioned axially by the delivery control sleeve **74** through the speed advance sleeve **76**, any axial movement of metering shaft sleeve **60** will induce appropriate road sensitive change in spark timing due to the movement of the distributor drive pin **128** in the spark advance breaker point cam slot **130** (FIGURE 4).

Therefore, at idle speed increases above 550 r.p.m., the outward movement of the governor weights will move the speed advance sleeve **76**, and through spring **88**, delivery control sleeve **74** downwardly against idle speed spring **90**; and, through pin **120**, the metering shaft sleeve **60**, to decrease the fuel supply. Decreases below 550 r.p.m. will cause the parts to operate in reverse, thus moving sleeve **60** upwardly to block the spill holes **52** for a greater period of time and cause an increase in the fuel delivery until the desired idle speed is reached.

At 800 r.p.m. the centrifugal force of the governor weights will have moved the delivery control sleeve **74** downwardly against idle spring **90** until the sleeve has bottomed against the washer **94** on driveshaft **26**. The governor, therefore, now will be ineffective to supply further increase in fuel flow until approximately 1,000 r.p.m. is reached (preload on spring **88**).

Assume now that greater engine speeds are desired, and throttle lever **144** is depressed. This will raise distributor driveshaft **22** upwardly proportionate to the lever movement, and with it delivery control sleeve **74** and metering shaft sleeve **60**. This will increase the fuel supply by blocking the spill holes **52** for a longer period.

As stated previously, the force of the speed advance sleeve spring is chosen so that no relative axial motion will occur between the speed advance sleeve **76** and delivery control sleeve **74** until a speed of approximately 1,000 r.p.m. is reached. Therefore, in the speed range between 800 and 1,000 r.p.m., fuel flow control will vary strictly as a function of throttle lever position (load). Appropriate spark timing advance will result from the axial movement of the distributor drive pin **128** in the vertical portion of the breaker point cam slot **130**. At different axial positions, therefore, the amount of fuel injection will change, as controlled by the axial and rotative positions of the metering shaft helix **58** (FIGURE 1); the ignition timing will, of course, change as controlled by the spark load-advance slot **130**.

Above 1,000 r.p.m. engine speed, the increase in the centrifugal forces on the governor weights will overcome the preload force of the speed advance spring **88**. Therefore, as the speed increases, for a constant throttle opening setting, speed advance sleeve **76** will begin to compress spring **88** and move sleeve **76** downwardly relative to delivery control sleeve **74**, which is resting against washer **94** on driveshaft **26**. The downward movement of speed advance sleeve **76** will move pin **78** in the diagonal portion of metering shaft slot **80** to rotate sleeve **60** relative to driveshaft **26** and thereby advance the circumferential position of metering helix **58**. Therefore, fuel now will be injected earlier than previously for a given rotation of the driveshaft, resulting in an advancement of the fuel injection to meet increased r.p.m. conditions.

The above relative rotative movement of the sleeve **60** is permitted by the horizontally elongated slot **124** (FIGURE 13) in which the torque control pin **120** moves. If desired, the slot could be angled as shown at **124'** in FIGURE 16 so that the metering sleeve **60** can then be subjected to an automatic speed-sensitive axial readjustment. By this means, any desirable wide-open throttle fuel delivery curve can readily be obtained.

Simultaneously, downward movement of speed advance sleeve **76** acts through pin **112** and slot **118** (FIGURE 11) to rotate distributor driveshaft **22** relative to main driveshaft **26**, and thus superimpose a further advance (depending upon the degree of depression of the accelerator pedal) on the distributor breaker point cam **134** so as to advance the spark as a function of the speed changes. This advance is permitted without disturbing the axial position of driveshaft **26** and the delivery control sleeve **74** by means of the horizontally elongated slots **116** (FIGURE 10) and **114** (FIGURE 9) in delivery control sleeve **74** and driveshaft **26**, respectively. If a modified fuel schedule is called for, a change in fuel delivery can be obtained by angling the straight slot **116** in FIGURE 110 in

the manner shown in FIGURE 15 to cause axial movement of sleeve **74** relative to the driveshaft.

In this 1000+ r.p.m. speed range, therefore, the axial position of the metering shaft sleeve **60** is primarily controlled by the position of throttle lever **144**; that is, the accelerator pedal. The axial displacement of the metering shaft sleeve **60** thereby induces an appropriate change of load sensitive spark timing through displacement of the upper distributor drive pin **128** in the spark load advance slot **130** (FIGURE 4).

The maximum downward movement of speed advance sleeve **76** occurs when the sleeve bottoms against the top of the delivery control sleeve **74**. From this point on, until a maximum or overspeed limit r.p.m. has been reached, a further increase in speed will not cause any further increase in fuel delivery, due to the pre-load force of overspeed spring **96**.

Within the above speed range, if throttle lever **144** is suddenly released, to decelerate the vehicle and engine, the resultant downward movement of distributor driveshaft **22**, delivery control sleeve **74**, and metering shaft sleeve **60** will position metering shaft helix **58** (FIGURE 1) for zero fuel delivery, by totally or entirely uncovering spill holes **52**. All of the fuel delivered by the pump is then spilled back into bore **24** or chamber **63** rotation of the assembly, and none is delivered out through delivery values **54** to the nozzles. This, of course, is due to the fact that the idle gap now is zero (spring **90** collapsed) as compared to being one-half open at engine idle speed, and speed advance sleeve **76** is resting against the top of the delivery control sleeve.

An overspeed fuel cutoff is provided when the engine r.p.m. exceeds a desired value. At this speed limit, the centrifugal forces of the governor weights are sufficient to overcome the pre-load of overspeed spring **96** and thereby move the entire fuel regulating assembly downwardly. The governor thus acts through the speed advance sleeve **76**, which is resting against the delivery control sleeve **74**, to move the metering shaft sleeve **60** downwardly through pin **120** and move metering helix **58** downwardly to decrease the fuel supply until the desired maximum speed level is obtained. Simultaneously, the lowering of the distributor driveshaft **22** lowers the drive pin **128** and thus rotates the spark advance cam **134** to change the spark advance in accordance with the decrease in fuel delivery. Correct spark timing is thus achieved whether over-speeding takes place from a wide-open throttle position of the throttle lever **144** or from any part load position. The above action, therefore, will gradually cut back fuel delivery to zero even if the throttle lever holds the governor shaft in wide-open throttle position.

Thus, it will be seen that the invention provides a fuel pump that is integrated with an ignition distributor in a single housing with a single set of governor weights and suitable controls interconnecting the two in a manner to provide coordinated changes in the spark advance or retard and the amount of fuel delivery with changes in load and speed.

While the invention has been illustrated in its preferred embodiments in the drawings, it will be clear to those skilled in the art to which it pertains that many changes and modifications may be made thereto without departing from the scope of the invention.

What is claimed is:

1. An integrated fuel pump and ignition distributor assembly comprising, a fuel pump, an ignition distributor having adjustable spark timing control means thereon, a drive shaft common to said pump and distributor for driving both at the same speed, a fuel discharge line, fuel delivery metering means rotatable with said drive shaft and associated with said pump and discharge line and movable to positions variable controlling fuel flow from said pump through said line as a function of its movement, and movable means operably connected both to said spark timing control means and said metering means for concurrent movement of said control and metering means to control fuel flow and adjustment of said spark control means in response to movement of said movable means.

2. An assembly as in claim **1**, said drive shaft being axially movable, said movable means being connected to said drive shaft for axial movement thereof.

3. An assembly as in claim **1**, said movable means including speed responsive means driven by said shaft.

4. An assembly as in claim **1**, said movable means including manually operable means.

5. An assembly as in claim **1**, said metering means and adjustable spark timing control means being movable relative to said drive shaft, said movable means including a single speed responsive means driven by said shaft and operably connected both to said metering means and said control means for movement thereof at times relative to said drive shaft to concurrently control fuel flow and spark advance as a function of changes in speed of said drive shaft.

6. An assembly as in claim **5**, said drive shaft being axially movably mounted, said movable means also including manually operable means movable at will and connected to said drive shaft for the simultaneous movement of said drive shaft and metering means and adjustment of said control means.

7. An integrated fuel injection pump and ignition distributor assembly comprising, in combination, a rotatable drive shaft having spark timing ignition distributor mechanism at one end and a fuel pump at the opposite end both rotatable therewith and each having portions mounted on said shaft for limited relative movements therebetween, said fuel pump having movable fuel flow metering means associated therewith rotatable with said shaft for controlling the discharge pressure of fuel from said pump as a function of the movements of said metering means, said distributor mechanism having adjustable spark advance means operably connected to said shaft and distributor portion for adjusting said advance means, and a plurality of movable means operably connected to said metering means and distributor mechanism providing movement thereof to simultaneously control both fuel delivery and spark advance adjustment.

8. An integrated fuel pump and ignition distributor assembly for use with an internal combustion engine of the spark ignition type comprising, a rotatable and axially movable main drive shaft, a fuel pump having a common fuel inlet and outlet chamber connected to a source of fuel and an input drive member operably connected to and driven by one portion of said drive shaft, an ignition distributor having a drive member and a breaker point cam fixed thereon and operably connected to and driven by another portion of said shaft, movable fuel flow metering means driven by said drive shaft and cooperating with said chamber for variably controlling fuel flow thereto and therefrom as a function of the movement of said metering means, means mounting said metering means for limited axial and rotative movement at times with respect to said drive shaft, manually operable engine throttle control means variably movable between engine idle speed and wide open throttle positions, means connecting said throttle means and said drive shaft for unitary axial movement of said shaft and metering means and distributor drive member in one direction in response to movement of said throttle means in one direction between said positions to thereby control fuel flow, drive shaft driven speed responsive means operably connected to said metering means for moving said latter means in the opposite direction, and adjustable spark advance means operably connected to said drive shaft and distributor cam and operable in response to axial movement of said drive shaft to control the spark timing advance position of said distributor cam.

9. An assembly as in claim **8**, said spark advance control means including cam and cam follower elements mounting said distributor drive member and said distribu-

tor cam for relative axial and rotative movements therebetween to vary the spark timing position of said distributor cam as a function of the axial position of said drive shaft, and thereby as a function of the load indicated by the position of said throttle means.

10. An assembly as in claim 8, said spark advance control means including cam and cam follower elements mounting said distributor drive member and said distributor cam for relative axial and rotative movements therebetween, and second cam follower means connecting said drive member and drive shaft for a limited rotation therebetween to vary the spark timing position of said distributor cam as a function of the relative rotation between said drive member and drive shaft.

11. An assembly as in claim 10, including means operatively connecting said second cam and cam follower means to said speed responsive means for varying spark advance as a function of change in speed of said drive shaft.

12. An assembly as in claim 8, said fuel flow metering means comprising a sleeve valve axially and rotatably slidably mounted on said drive shaft and variably movable across said fuel pump fuel chamber to control fuel flow thereinto and therefrom as a function of the position of said valve.

13. An assembly as in claim 8, including spring means biasing said metering means in one direction to one fuel flow control position, said speed responsive means acting at times on said metering means to move said latter means in the opposite direction to other fuel flow control positions.

14. An assembly as in claim 12, including spring means biasing said valve to one fuel flow position in opposition to the force applied to said valve by said speed responsive means, and cam and cam follower means operatively connecting said valve and drive shaft and speed responsive means operable in response to the attainment of a predetermined speed of rotation of said drive shaft for rotating said sleeve relative to said drive shaft to vary the fuel flow control by said metering means.

15. An integrated fuel injection pump and ignition distributor assembly for use with an internal combustion engine of the spark ignition type comprising, in combination, a fuel injection pump of the swash plate type having a drive shaft axially slidably mounted in a central bore of said pump and connected to and progressively reciprocating a plurality of pump plungers concentrically and slidably mounted about said shaft, each of said plungers having a fuel chamber adjacent one end, a fuel discharge line connected to said bore and intersected by said chamber, a fuel flow metering valve drivably connected to and surrounding said shaft and variably slidable across said line upon axial movement of said valve to control fuel flow between said chamber and line and bore, an ignition distributor having a driving member axially aligned with and secured to said drive shaft for rotation and axial movement therewith and having a breaker point cam mounted on said drive member for limited relative rotation and for axial movement therewith, cam and cam follower means between said driving member and breaker point cam operable in response to relative axial movement between said latter cam and driving member for rotating said breaker point cam relative to said drive member to vary the spark timing position of said breaker point cam, a manually operable engine throttle member movable between engine idle speed and wide open throttle positions and connected to said drive shaft for axially moving said shaft and metering valve sleeve and distributor drive member as a unit in one direction in response to movement of said throttle means in one direction between said positions to vary fuel flow to said line and vary the position of said breaker point cam, a single speed responsive means secured to said drive shaft for rotation therewith, means connecting said speed responsive means and said sleeve valve for movement of said valve axially in the opposite direction relative to said drive shaft in response to predetermined changes in speed of said drive shaft, and spring means operably biasing said sleeve valve to an initial position in opposition to the force of said speed responsive means.

16. An assembly as in claim 15, said means connecting said speed responsive means and said sleeve valve comprising cam and cam follower means effecting rotation of said sleeve valve relative to said drive shaft upon the attainment of a predetermined speed or rotation of said drive shaft for varying the fuel flow to said line as a function of drive shaft speed changes and the load on said engine as determined by the position of said throttle means.

17. An assembly as in claim 15, including cam and cam follower means operably connecting said speed responsive means and said distributor drive member effecting rotation of said distributor drive member relative to said drive shaft upon the attainment of a predetermined speed of said drive shaft to vary the position of said breaker point cam as a function of drive shaft speed changes.

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