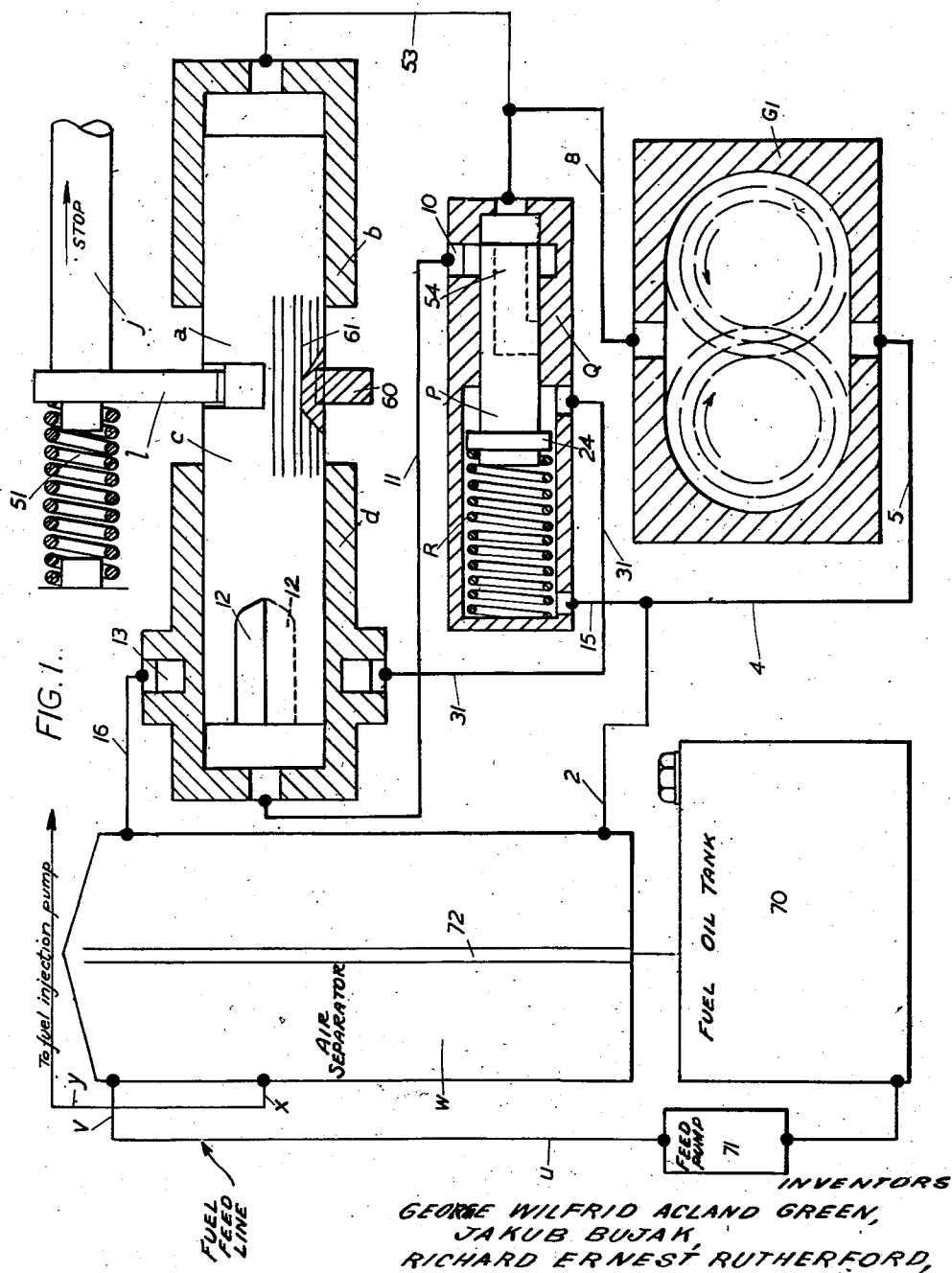


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HYDRAULIC GOVERNOR

7 Sheets-Sheet 1



July 13, 1948.

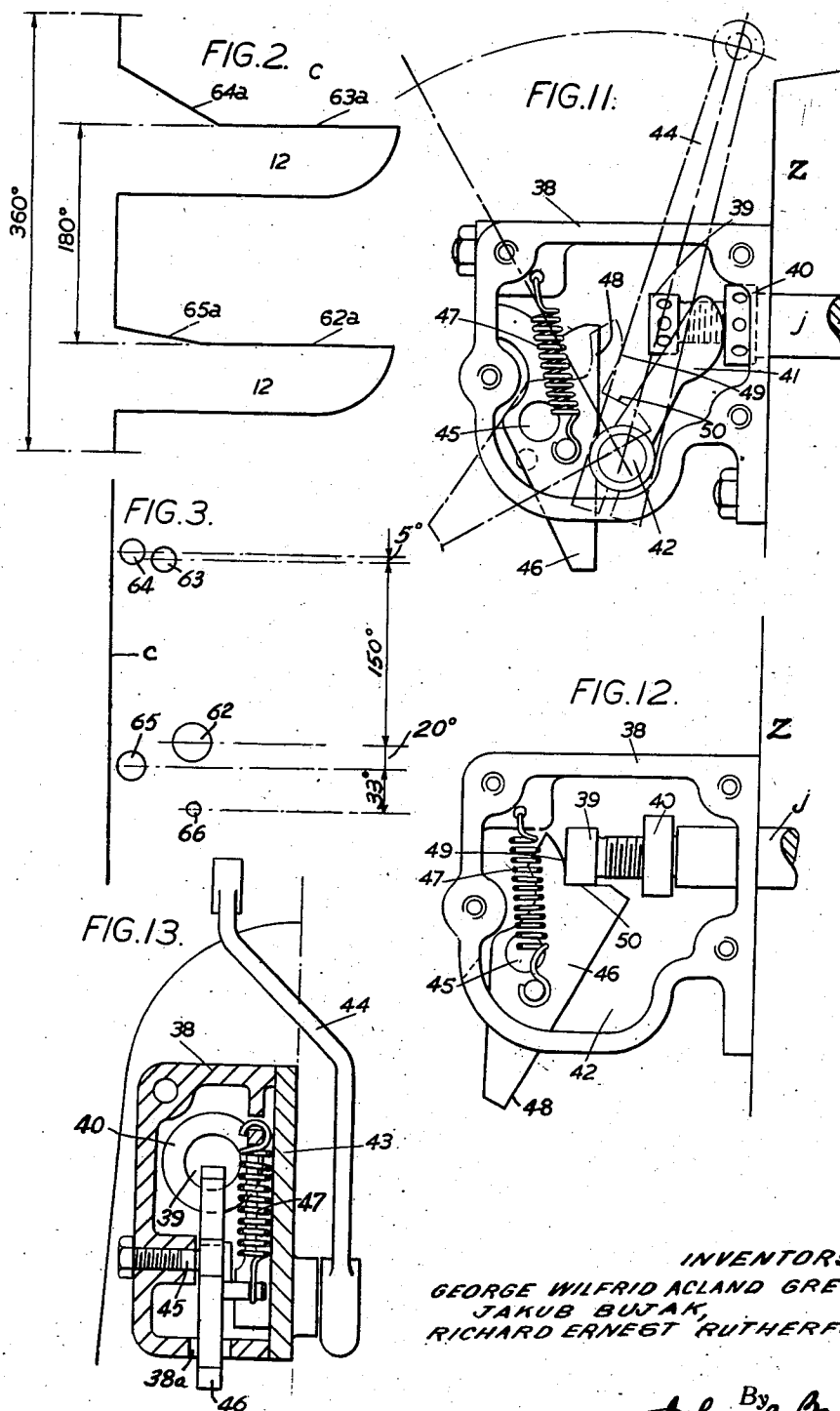
G. W. A. GREEN ET AL

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HYDRAULIC GOVERNOR

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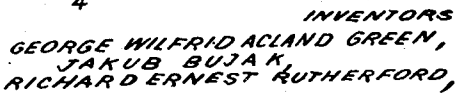
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HYDRAULIC GOVERNOR

7 Sheets-Sheet 3



By John B. Brady
Attorney

July 13, 1948.

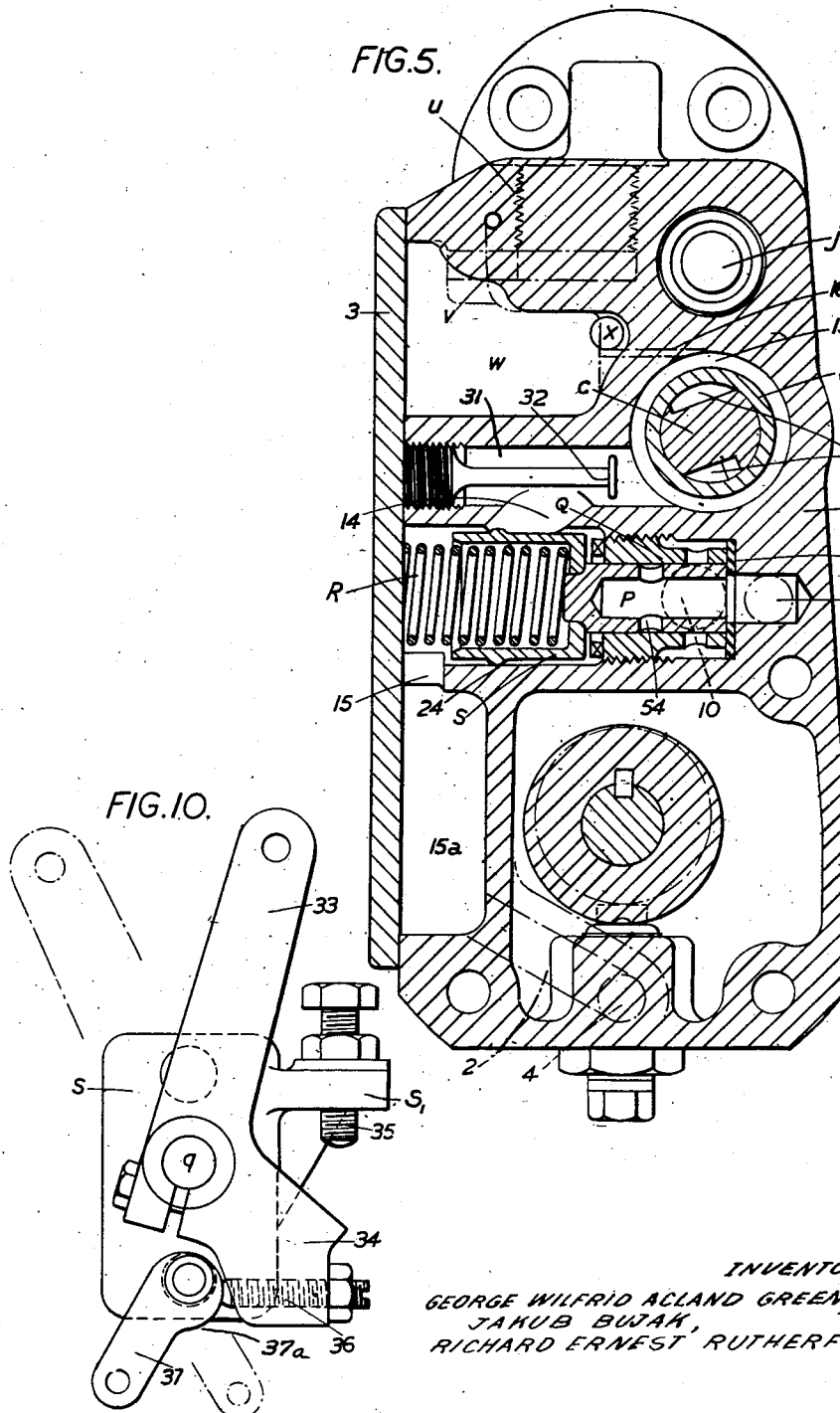
G. W. A. GREEN ET AL

2,445,113

HYDRAULIC GOVERNOR

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7 Sheets-Sheet 4



INVENTORS
GEORGE WILFRID ACLAND GREEN,
JAKUB BUJAK,
RICHARD ERNEST RUTHERFORD,

By *John B. Brady*
Attorney

July 13, 1948.

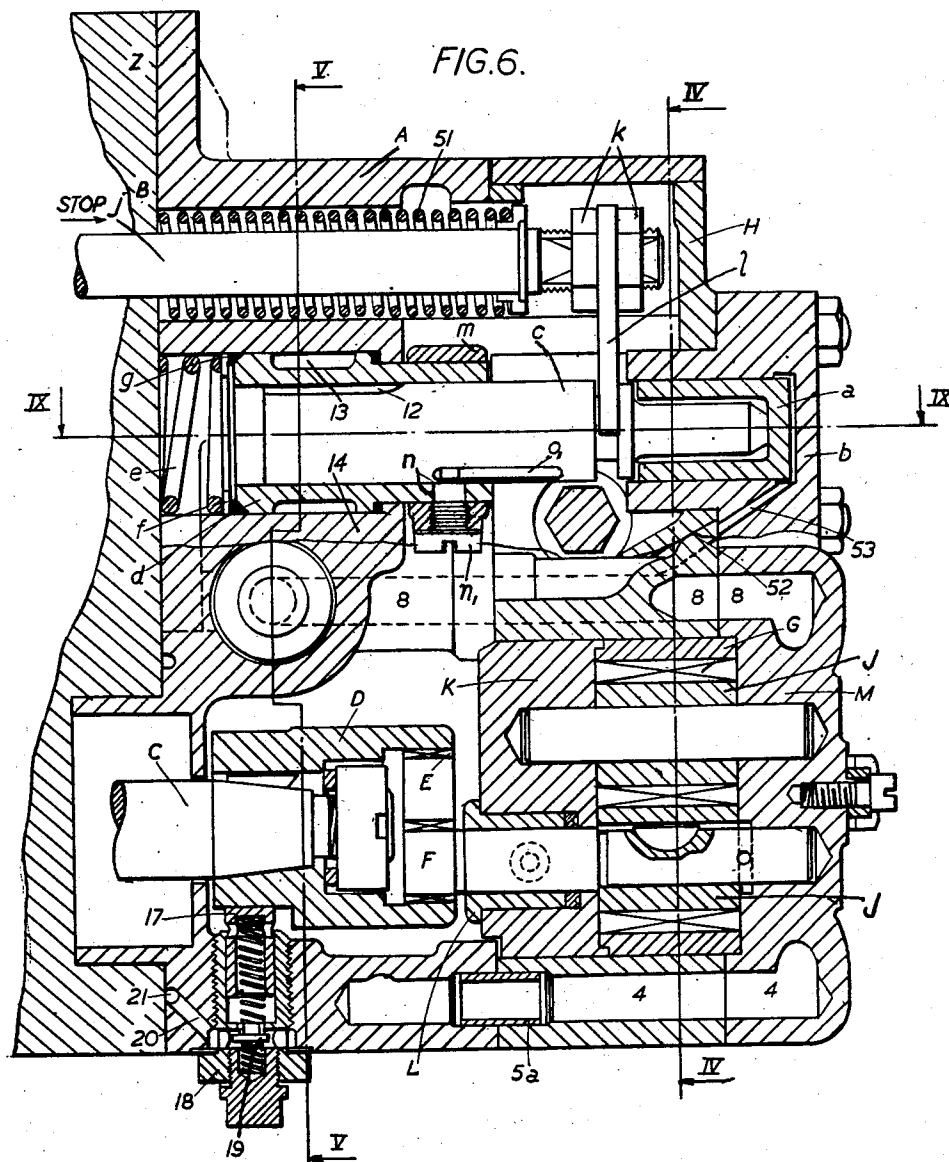
G. W. A. GREEN ET AL

2,445,113

HYDRAULIC GOVERNOR

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7 Sheets-Sheet 5



INVENTORS
GEORGE WILFRID ACLAND GREEN,
JAKUB BOJAK,
RICHARD ERNEST RUTHERFORD,

By
John B. Grady
Attorney

July 13, 1948.

G. W. A. GREEN ET AL

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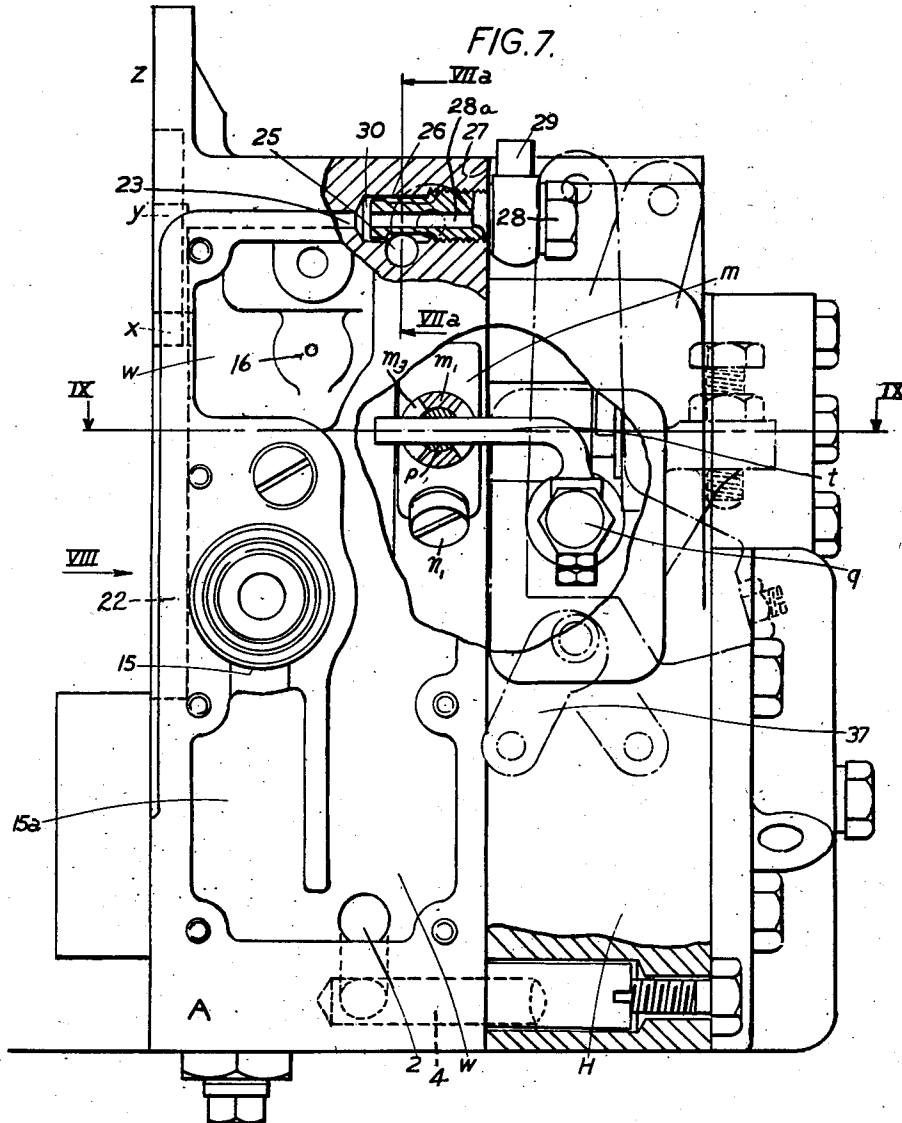
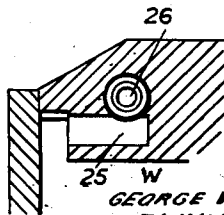


FIG. 7A.



INVENTORS
GEORGE WILFRID ACLAND GREEN,
JAKUB BUJAK,
RICHARD ERNEST RUTHERFORD,

By *John Q. Brady*
Attorney

July 13, 1948.

G. W. A. GREEN ET AL
HYDRAULIC GOVERNOR

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7 Sheets-Sheet 7

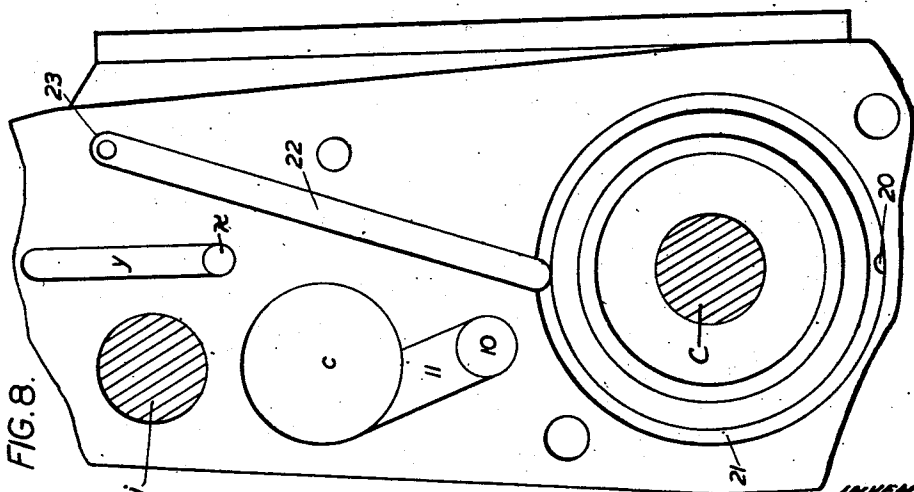


FIG. 8.

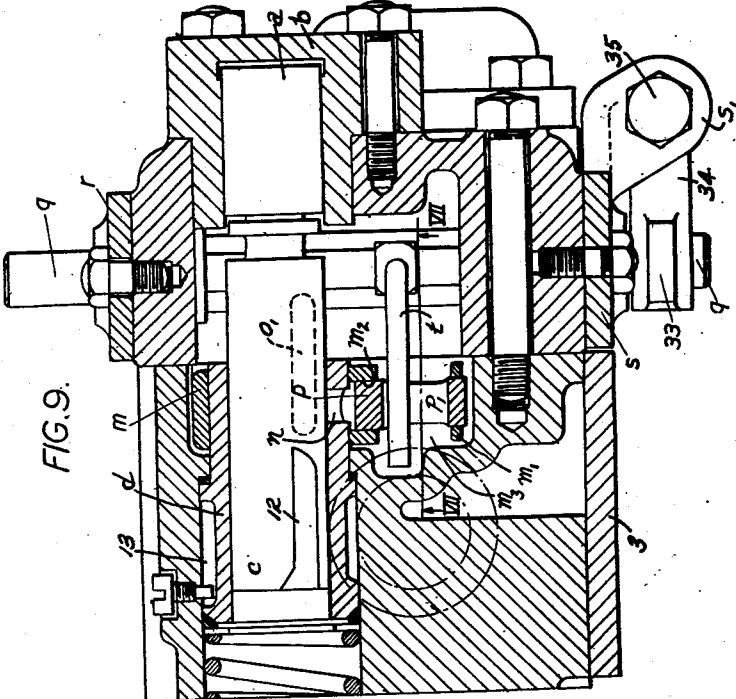


FIG. 9.

GEORGE WILFRID ACLAND GREEN,
JAKUB BUJAK,
RICHARD ERNEST RUTHERFORD,
By *John B. Grady*
Attorney

UNITED STATES PATENT OFFICE

2,445,113

HYDRAULIC GOVERNOR

George Wilfrid Acland Green and Jakub Bujak,
Staines, and Richard Ernest Rutherford, Wind-
sor, England, assignors to Lagonda Limited,
Staines, Middlesex, England

Application May 7, 1943, Serial No. 486,064
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19 Claims. (Cl. 264—14)

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This invention relates to the kind of fluid operated governor, for variable speed engines designed to operate over a wide speed range and especially variable speed internal combustion engines of the fuel injection type, that comprises a displacement pump adapted to be driven at a speed proportional to that of the engine, and a spring-loaded control plunger subjected to the fluid pressure created by the pump under the control of a manually variable leak-off orifice for the fluid.

The invention consists of improvements in that set forth in the specification of Patent No. 2,293,814 which, in a governor of the aforesaid kind, protects principally means for modifying the response of the spring-loaded plunger at a particular part of the speed range thereby to bring about greater percentage "run-up" at lower speeds with respect to the "run-up" at higher speeds, said means being brought into and cut out of operation dependently on the control of the manually variable leak-off orifice.

According to one feature of the present invention a fluid operated governor embodying plunger response modifying means as claimed in patent specification No. 2,293,814 has a double acting plunger, the fluid pressure acting on one end of which is controlled by an automatically acting release valve, while that acting on the other end is controlled by the manually operated leak-off orifice as in the said specification, thereby enabling the plunger loading spring to act in a direction tending to shut off the fuel and making the governor safe should the engine start to run in the reverse direction or should the fluid supply to the governor fail for any reason.

Another feature of the present invention resides in combining the functions of the control plunger and the manually variable rotary valve referred to in patent specification No. 2,293,814 in a single element, namely, the control plunger which has longitudinal motion under the action of the fluid pressure and loading spring, as before, but is also adapted to receive independent rotary motion under manual control to vary the effective leak-off area through ports in its barrel. This feature simplifies the construction and increases the efficiency of the governor; moreover, it leads to other advantages as will appear hereinafter.

When, as is general, the fluid operating the governor is the fuel supplied to the engine, we prefer to include in the supply system means to ensure that in case of failure or partial failure of the fuel supply the governor will continue to

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operate normally until the engine stops through the fuel injection pump being starved, so that all danger of the engine racing through improper action of the governor following the said failure but before the actual engine stoppage is avoided. This means may take the form of an air-separator which, if air leaks into the system, separates the air from the air-fuel mixture then supplied, a small amount of entering air having no effect but a large amount reducing the quantity of fuel delivered to the injection pump below its demand although the fuel content of the separator will keep the governor supplied and operating properly until the engine stops.

Another feature of the invention consists in arranging that the speed control of the governor is rendered independent of variations in the pressure at which fuel is fed to the governor.

Preferably the aforesaid release valve is of the spring-loaded type, provision being made to compensate automatically for the increased force exerted by the spring as the lift of the valve increases with increased speed of the engine and therefore greater output of the displacement pump. Preferably also the release valve is such that it acts as a safety valve in the event of the pump tending to develop excessive pressure as happens when the engine is forced above the speed for which the control is set (e. g. as in a vehicle running downhill or when gear changing).

A further feature of the invention is the insertion on the down-stream side of the control ports which constitute the leak-off orifice of a fixed orifice of such area that it limits the maximum speed of the engine to a value slightly in excess of the normal maximum, thus preventing the engine from being overspeeded through unauthorised persons tampering with the setting of the external speed limiting adjustment to be described later.

By way of example one form of governor embodying the foregoing and other features of the invention is illustrated by the accompanying drawings.

Fig. 1 represents the governor schematically. Fig. 2 represents a plane development of one end portion of the plunger.

Fig. 3 represents, on the same scale as Fig. 2, a plane development of the control ports through the plunger barrel.

Figs. 4 to 9 are assembly views depicting the constructional features of the governor—Fig. 4 being an end elevation partly in section on line IV—IV of Fig. 6; Fig. 5 a cross sectional elevation on the broken line V—V of Fig. 6; Fig. 6 a

longitudinal section on the broken line VI—VI of Fig. 4; Fig. 7 a side elevation with the air separator cover removed and partly in section on line VII—VII of Fig. 9; Fig. 7a a section on line VIIa—VIIa of Fig. 7; Fig. 8 an end view of the governor looking in the direction of the arrow VIII in Fig. 7; and Fig. 9 a sectional plan on lines IX—IX of Figs. 6 and 7.

Fig. 10 shows in detail the idling and maximum speed adjustment mechanism, which also appears in Figs. 7 and 9.

Figs. 11 to 13 show details of the maximum fuel stop and device for giving excess fuel for starting, which are associated with the fuel pump control rod.

As shown in Fig. 1, the control circuit of the governor comprises a gear pump G_1 , which is driven by the engine and delivers fuel through a passageway 8 to a release valve body Q having a plunger valve P loaded by a spring R . In the valve body there is a port 10 leading, by a passageway 11, to the end of a barrel d in which works the left-hand portion c of a control plunger whose other end portion a works in a barrel b . A passageway 53 leads pressure fuel from the gear pump G_1 to the end of the barrel b .

The fuel injection pump control rod j is adapted to move to the right to cut off the fuel supplied to the engine and to the left progressively to increase the fuel supplied; it is urged to the right by a spring 51, and it carries a fork l engaging an annular groove in the control plunger c, a . The control rod j is the member by which the quantity of fuel delivered to the engine and hence its power output is controlled. In the case of engines using a well known form of fuel injection pump working on the "jerk injection" system, the rod j controls, by well known means, the angular position of the plungers of the fuel injection pump and hence the effective length of their delivery stroke.

Independently of its sliding movements under the pressure of the fuel delivered by the pump G_1 , the control plunger is adapted to be turned manually about its axis by any appropriate means. In the schematic view, Fig. 1, this means is represented as a toothed rack 60 engaging teeth 61 formed in the surface of the plunger, but in the constructional embodiment illustrated by Figs. 4 to 13 other means are adopted as will be hereinafter described.

Formed in the surface of the control plunger portion c there are two axial grooves 12, 12 affording control edges for a number of ports extending radially through the plunger barrel d into an annular chamber 13. The disposition of the said control edges and the co-operating ports will be clear from the plane developments, Figs. 2 and 3. Port 62 is the main leak-off orifice and is controlled by the edge 62a and, since this edge is axial, longitudinal movement of the plunger does not affect the orifice area. Ports 63, 64 together form an idling orifice and are controlled by the edges 63a, 64a of which the edge 64a is so placed that it co-acts with the said ports only when the plunger is towards the idling end of its travel and also when the angular position of the plunger is such that the aforesaid port 62 is completely closed by the edge 62a. As the plunger is turned to open the port 62, ports 63, 64 are fully uncovered and remain so, thus constituting, in this angular position of the plunger, a part of the main leak-off orifice. A port 65 serves as a transition orifice and is controlled by the edge 65a when the plunger is in such an

angular position that the ports 63, 64 are partly uncovered by the edge 63a. The edge 65a, being inclined at a smaller angle to the plunger axis than the edge 64a, provides a small stabilizing effect and produces a smooth change-over from the idling condition to operation on the main leak-off orifice. A fifth port 66 is shown provided in the plunger barrel in such a position that it is always uncovered. Before the engine is started the control plunger is at the extreme right-hand end of its travel and must be pushed by the end pressure in the barrel b (Fig. 1) to the left to enable the engine to fire. If the control is set for idling the plunger a, c can move a certain distance after which the idling ports 63, 64 are sealed by the edge 64a and there would be no egress for the fuel from the plunger barrel d without the provision of the aforesaid port 66. However, the port 66 may be omitted in which case the amount of fuel delivered to the engine when starting will be limited unless the control is set for some higher speed than idling.

Reverting to Fig. 1, fuel leaves the annular chamber 13 by a conduit 31 and enters the closed space in the release valve body Q that contains the spring R and the head of the valve P . On the head of the valve P is formed an enlargement 24 affording a suitable clearance within the bore of the body Q . The fuel that enters the said closed space from the conduit 31 flows through this clearance and leaves the release valve body by conduits 15, 4 and 5 which lead it back to the suction side of the gear pump. The small drop of pressure consequent on the flow of the fuel past the enlargement 24 acts on the valve P and is so adjusted as to compensate for the increased force exerted by the spring R when the valve lift is increased by increased flow of fuel, thus maintaining an approximately steady value of the difference between the pressures acting on the two ends of the release valve.

Fuel oil is supplied from a tank 70 by means of a feed pump 71, which may be of any of the well known forms that maintain a fixed low pressure on the delivery side irrespective of the demand. The fuel is delivered by passageway u, v into an air separator w at a point near its top, and a portion returns, via a vent connection 72, to the supply tank 70, said vent connection being small enough in diameter to enable the feed pump 71 to maintain pressure in the separator. From a point about one-third from the top of the separator fuel is led by passageway x, y to the suction connection of the fuel injection pump (not shown in Fig. 1) and from a point near the bottom of the separator fuel is led by passageway 2, 4, 5 to the suction side of the gear pump G_1 .

A passage of restricted bore 16 connects the highest point of the annular groove 13 to a point near the top of the separator w .

The operation of the governor is as follows:

Assuming the engine to be at rest and the separator w full of fuel, the control plunger a, c and the fuel injection pump control rod j will be pushed fully to the right by the spring 51, and the release valve P will also be pushed fully to the right by its spring R . When the engine crankshaft is rotated (by hand or other means) to start the engine, the gear pump G_1 draws fuel from the separator and generates pressure on its delivery side. This pressure, acting on the end of the control plunger portion a , pushes the plunger and the control rod to the left against the spring 51, thus setting the fuel injection pump

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for full fuel delivery to the engine. At the same time the fuel feed pump 71 generates a low pressure and fuel is supplied to the injection pump, via the separator *w* and passageway *x*, *y*, and the engine starts. Thus, the engine gets full fuel for starting irrespective of the position of the manual control 60.

As the engine gathers speed, after starting, the pressure on the right-hand end of the release valve *P* compresses the spring *R* and displaces the valve to the left until the port 10 is exposed, whereupon fuel flows, by passageway 11, to act on the end of control plunger portion *c*. Said fuel flows down the grooves 12 and according to the angular setting of the plunger by the manual control 60, through some of the control ports 63 to 65 (Fig. 3) into the annulus 13, whence it passes, by the passageway 31, into the closed space of the release valve body *Q* that houses the spring *R* and then past the enlargement 24 and through passageway 15, 4 and 5 back to the suction side of the gear pump *G*₁. The release valve acts to maintain a constant pressure difference between the suction and delivery sides of the said gear pump irrespective of the engine speed or of the pressure generated by the fuel feed pump.

Let *P*₀ denote the pressure generated by the feed pump, and *P*₁ the said pressure difference. Then the pressure acting on the control plunger portion *a* is clearly *P*₁ plus *P*₀.

Let the pressure drop set up by the flow of fuel through the control ports be *P*₂. Then the pressure on the control plunger portion *c* is *P*₂+*P*₀. Of course *P*₂ depends on the exposed area of the control ports (i. e. on the setting of the rack 60) and the speed of the engine.

Let *P*₃ denote the spring pressure exerted per unit of area on the control plunger *a*, *c* by spring 51.

Then the force acting on unit area of the control plunger in a direction tending to move it to the left is

$$(P_1 + P_0) - (P_2 + P_0) - P_3$$

When the plunger is in equilibrium this must be zero, or

$$P_2 = P_1 - P_3$$

Thus, the engine speed will increase until at any setting of the rack 60, this condition is established.

If the load on the engine decreases its speed at first rises so that more fuel is delivered past the release valve and *P*₂ increases. The control plunger then moves to the right, reducing the fuel supply to the engine so that it slows up. *P*₂ thus falls again, but owing to the new position of the rack, *P*₃ is slightly less than before and equilibrium is reached at a correspondingly higher value of *P*₂. Governing action is therefore exactly the same as in the arrangement per patent specification No. 2,293,814. However, the present arrangement manifests advantageous features now to be referred to.

If for any reason the rotation of the engine is reversed, the governor gear pump *G*₁ is likewise reversed, so that it sucks from passageway 8 and delivers to passageway 5. No pressure is then generated in the control plunger barrel *b* and the control rod *j* remains in the "stop" position so that no injection of fuel takes place.

If air leaks into the fuel system, a mixture of fuel and air or air alone may enter the separator *w*. If the amount of such air is small it passes

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from the separator via the vent connection 72 to fuel supply tank 70 and has no effect. On the other hand, if the amount of such air is so great that the amount of fuel delivered to the separator *w* falls below the demand of the fuel injection pump, the level of fuel in the separator will fall until the injection pump draws air and the engine, in consequence, is stopped; but meanwhile the governor is kept supplied with fuel from the lower part of the separator and so operates normally. As hereinafter explained with reference to Figs. 4 to 13, the separator is formed as part of the governor casing, and failure of the connection between the separator *w* and the gear pump *G*₁ is practically impossible. Should a slight leak occur at a joint or at the pump gland air would reach the annulus 13 in the control plunger barrel *d* and would pass, by the passageway 16, to the separator vent, thereby making it impossible for the governor to become ineffective due to accumulation of air. Obviously, the air outlet from the annulus 13 is made sufficiently small in diameter to prevent any fuel that also passes therewith from disturbing the action of the separator. As the whole system is normally kept above atmospheric pressure by the feed pump, entry of air on its discharge side is practically impossible.

Since, as already explained, the force acting on the control plunger is independent of the pressure generated by the feed pump, the action of the control plunger is not effected by irregular operation or failure of the feed pump, and the governor will function normally so long as there is fuel in the separator to feed the governor gear pump *G*₁.

If the engine is forced to run above the speed for which the manual control is set (as e. g. in a vehicle when running downhill), the gear pump *G*₁ tends to develop excessive pressure, whereupon the release valve *P* moves so far to the left that the duct 54 opens as a safety valve.

These features make the governor safe and reliable under all foreseeable conditions.

Referring now to Figs. 4 to 13 for the constructional details of the governor and their assembly into a unitary whole, it will be seen that the main member *A* (Fig. 6) of the governor casing is bolted by its face *B* to the body of the fuel injection pump *Z* which the governor controls. The protruding end of the fuel injection pump camshaft *C* carries an internal gear *D* having teeth *E* meshing with those of a pinion *F* formed on the drive spindle of the governor gear pump. The body *G* of the gear pump is carried in the outer member *H* of the governor casing; and the pump gears *J*, *J*, have their spindles journaled in end covers *K*, *M*, the drive spindle passing through a bush *L* in the cover *K*. The pump body *G* and its end covers *K*, *M* are held together by two bolts *N* (Fig. 4) and the entire pump is attached to the governor casing member *H* by studs *O*.

The release valve *P* is best shown by Fig. 5; it works in the barrel *Q* which is screwed into the governor casing member *A* and abuts a joint ring 9. The valve is controlled by the spring *R* butting against a piston *S* which carries the external projection or enlarged head 24 that co-operates with the walls of the chamber housing the said piston to afford the restriction necessary to provide compensation for the rate of the spring *R*, i. e. for the increased force exerted by the spring as the displacement of the valve increases with increasing engine speed.

The barrel *b* for the balance plunger *a* (Fig. 6)

associated with the control plunger *c*, is bolted to the governor casing member *H*, and the barrel *d* for the said control plunger is held in the governor casing member *A* by a spring *e*, washer *f* and soft packing rings *g* and *h*. The right-hand end of the fuel injection pump control rod *j* is screw-threaded and has two flats over which fits the connecting piece *l*, the same being prevented from turning on the rod by the said flats but its axial position thereon being adjustable by two lock nuts *k, k*. At its lower end the connecting piece engages an annular recess in the control plunger, which it urges to the right under the action of the spring *51*.

Surrounding the barrel *d* is a yoke *m* (Figs. 6, 7 and 9) and in the inner end of the barrel is a slot *n*. A screw *n₁* in the yoke projects through this slot into a keyway *O₁* in the plunger *c*, so that any turning movement of the yoke is communicated to the plunger. The yoke has a radial projection *m₁* bored at *m₂* to receive a sliding plug *p*. The manually operated speed control shaft *q* passes transversely through the governor casing member *h*, being carried in brackets *r, s*. It carries a finger *t* which passes through clearance openings *m₃* milled in the radial projection of the yoke and is a sliding fit in a transverse opening *p₁* through the plug *p*. In this way rotation of the shaft *q* is transferred to the plunger *c* so that its angular position can be manually adjusted whilst leaving it free to slide axially.

Fuel is supplied to the governor under slight pressure, as previously explained, and enters the governor casing at *u* (Fig. 5) whence it flows through hole *v* into the separator chamber *w*. From the separator *w* the hole *x* and groove *y* (Figs. 7 and 8) lead to the suction-connection in the body of the fuel injection pump *Z*. The separator is cored in the casing member *A* and is closed by a cover plate *3* (Figs. 4, 5 and 9). From the bottom of the separator a drilled port *2* meets another drilled port *4* along which the fuel flows, through the casing members *A, H* into the gear pump end cover *M*. A hollow dowel *5a* is provided for locating casing member *H* with respect to casing member *A*. Port *4* leads to diagonal port *5* (Fig. 4) which communicates with the suction chamber *6* of the gear pump, the said chamber surrounding one of the aforesaid bolts *N*. After passing through the gear pump the fuel is led from the delivery chamber *7* surrounding the other of the bolts *N* and a diagonal port (not shown but corresponding to port *5*) to the port *8* which leads it from the pump end cover *M* through the casing member *H* to the casing member *A* (Fig. 6) where it reaches the release valve (see also Fig. 5). A branch port *52* is drilled from the outer face of the casing member *H* into the port *8* and registers with the port *53* in the flange of the barrel *b*, thus leading the delivery pressure fuel of the gear pump to the balance plunger *a*. The size of the port *53* is so selected as to damp any vibration or flutter of the plunger that might otherwise tend to develop, but it is large enough not to restrict rapid response of the governor.

When the fuel pressure displaces the release valve *P* against its spring *R*, fuel passes into the port *10* (Fig. 5) whence it is led to the joint face between the casing member *A* and the injection pump body *Z* and thence, via duct *11* (Fig. 8), to the end of the main control plunger *c*. The generation of dangerously high pressure in the gear pump is prevented in that excessive pressure displaces the release valve to such an extent that

its duct *54* overlaps the end of the housing *Q* to return the discharge from the gear pump directly to its suction side.

In Figs. 5 and 6 can be seen the grooves *12* in the plunger that co-operate with the control ports *62-66* (Fig. 3) in the manner already described; and the annulus *13* to which the fuel passes through the said control ports is also seen in these figures. From the annulus *13* the fuel passes to the duct *31* (Fig. 5) into which is screwed a plug having an enlarged head *32* to co-operate with the wall of the duct and form a maximum speed restricting orifice. Passing this orifice, which cannot be altered without dismantling the governor, the fuel flows through port *14* into the chamber housing the spring *R* of the release valve where it acts on the projection *24* of the piston *S* to effect compensation for the rate of the spring *R*. Finally it returns through port *15*, space *15a* and port *2* to the suction side of the gear pump.

A small scavenge pump of well known type is fitted in the base of the casing *A* to deal with any fuel that may leak into the interior of the governor casing; it comprises a plunger *17* (Fig. 6) working in a barrel *18* screwed into the casing *A*, the plunger being driven by an eccentric formed on the hub of the aforesaid internal gear *D*. Fuel forced past the delivery valve *19* of this scavenge pump flows through ports in the barrel to a duct *20* leading to a circular groove *21* (see also Fig. 8) formed in the end face of the casing member *A* that bolts up to the body *Z* of the injection pump. From groove *21* the fuel passes up a groove *22* to a duct *23* which, as shown in Fig. 7, has its inner end (drilled from the other face *27* of the casing member *A*) enlarged at *26* and threaded to receive a plug *28* securing a banjo fuel outlet connection *29*. The banjo plug has an axial hole *28a* and is reduced in diameter to afford a larger head *30*, which fits with fine clearance in the bore *26*, thus forming a restricted passage. A hole *25* is drilled, as shown in Figs. 7 and *7a*, leading from the highest point of the separator chamber *w* to break into the bore *26*. Due to the pressure maintained in the separator by the fuel feed pump there is a constant flow through hole *25*, past the restriction between *30* and *26*, and thence joining the discharge from the described scavenge pump out through *28* and *29* to the main fuel supply tank. Thus, any air that inadvertently enters the separator *w* is discharged through *25* and returned to the fuel tank where it can separate from the fuel. To preclude the possibility of air accumulating in the governor gear pump circuit, a small hole *16* (Figs. 5 and 7) is drilled from the separator *w* into the annulus *13* in the control plunger barrel *d*, so that any air in this circuit passes through *16* into the separator where it rises and is discharged through the hole *25*.

Speed control of the engine is effected by movement of a lever *33* (Figs. 9 and 10) mounted on one end of the manual control shaft *q*. In order that the maximum speed of the engine may easily be adjusted, the lever *33* is provided with a heel *34* which abuts an adjustable stop *35* consisting of a screw and lock nut, the screw passing through a lug cast on the bracket *s*. For limitation of the lever movement towards the idling position, it is provided with an adjustable screw *36*, the end of which bears against the lever *37*. This lever is provided with an eccentric cam *37a* so that by adjusting its position the limiting position of the lever *33* may easily be controlled

from a convenient position such as the dashboard of a vehicle.

At the opposite end of the injection pump body Z to that at which the governor casing A is mounted, there is fixed a small casing 38 (Figs. 11-13) into which the end of the fuel injection pump control rod *j* projects, being provided at this end with an adjustable screw 39 locked by means of a nut 40. A lever 41 mounted on a pin 42 carried in the cover 43 of the casing 38 is arranged so that it can be made to bear against the lock-nut 40 and, by means of the external lever 44, can be moved to force the control rod *j* to the "stop" position and thus bring the engine to rest. In the casing 38, there is also mounted on a pin 45 a trigger 46. A spring 47, arranged as shown, tends to hold the trigger 46 in either one of its two extreme positions. In normal running the trigger is in the position shown in full lines in Fig. 11 and its face 48 forms a stop for the control rod *j* which limits the maximum travel of this rod and thus the maximum delivery of fuel that which is usually referred to as the "smoke stop." Adjustment for the exact amount of fuel delivered under these conditions is provided by means of screw 39 and lock-nut 40. In some types of engine, when starting up from cold it is desirable to supply the engine with a greater amount of fuel than is permitted by the smoke stop. For this purpose, the trigger 46 is made to project through a slot 38a in casing 38 and can be set by hand to the position shown in chain-dotted lines in Fig. 11. This can be done when the engine is at rest. As soon as it begins to turn under the influence of the starter or starting handle the pressure which is generated in the barrel *b* pushes the control rod *j* to the left (Fig. 12) so that the head of the screw 39 comes against the curved surface 49 of trigger 46. It pushes this against the action of the spring 47 until the trigger passes its balance position and springs round so that the flat 50 bears on the side of the head of the screw 39. The control rod is then able to continue to move until it is arrested by the surface 49. In this position of the control rod *j* the engine receives more fuel than when the rod *j* abuts the face 48. The rod remains in this position until the engine fires and gathers speed. As soon as the engine reaches the speed for which the manual control lever 33 is set, the fuel injection pump control rod *j* is withdrawn to the right by the governor, clearing the trigger and allowing it to spring into its working position.

The governor now operates in the manner described with particular reference to Fig. 1, but that description of its operation may be easily re-read with reference to Figs. 4 to 9 as a fitting conclusion to this description of the invention.

We claim:

1. In a fluid operated governor for variable speed engines the combination of a displacement pump adapted to be driven at a speed proportional to that of the engine for volumetrically pumping fluid in proportion to the speed of the engine in a single closed circuit, intake and discharge connections for said pump, a double ended cylinder supplied with fluid pressure through said connections, a double acting plunger in said cylinder spring-loaded in a direction to shut off the fuel and having both ends subjected to fluid pressure created by the pump, a manually variable leak-off orifice controlling the pressure fluid acting on one end of the plunger, automatic means comprising a leak-off orifice the area of which is varied automatically by said plunger as the plunger

moves towards a position affording minimum fuel admission enabling greater percentage run-up at lower speeds with respect to the run-up at higher speeds, and an automatic release valve connected with the intake and discharge connections of said pump for controlling the fluid pressure acting on the other end of the plunger, whereby the governor is safeguarded should the engine start to run in reverse or should the fluid supply to the governor fail.

2. A fluid operated governor according to claim 1, including, a spring, said spring operating to bias the release valve to its closed position, and means automatically compensating the increased force of the spring as the displacement of the valve increases with increasing speed of the displacement pump.

3. A fluid operated governor according to claim 1, the automatic release valve comprising, a cylinder and an aligned chamber, a plunger slidable in the cylinder, and a head on the plunger working in the chamber and affording therewith a restriction for the passage of fluid from the leak-off orifice, whereby a pressure drop is attained at this point to compensate for the increased force of the spring as the displacement of the valve plunger is increased.

4. A fluid operated governor according to claim 1, including, a passage from the leak-off orifice to the suction side of the displacement pump, and means providing a restricted orifice in said passage to attain a throttling effect of the passing fluid, thereby to limit the maximum engine speed to a predetermined figure.

5. A fluid operated governor according to claim 1, including, a passage from the leak-off orifice to the suction side of the displacement pump, and means providing a restricted orifice in said passage thereby to limit the maximum engine speed to a predetermined figure, said means disposed to be inaccessible without dismantling the governor.

6. A fluid operated governor according to claim 1, in which the double acting plunger operates a control rod, said control rod including a trigger, and an adjustable stop on the control rod co-operating with the trigger, said trigger in one setting enabling the control rod to be moved to a position to give excess fuel for starting from cold.

7. A fluid operated governor according to claim 1, in which the double acting plunger operates a control rod, said control rod including a trigger, and an adjustable stop on the control rod co-operating with the trigger, said trigger in one setting enabling the control rod to be moved to a position to give excess fuel for starting from cold, and means for automatically moving the trigger from said setting when the engine starts.

8. In a fluid operated governor for variable speed engines the combination of a displacement pump adapted to be driven at a speed proportional to that of the engine for volumetrically pumping fluid in proportion to the speed of the engine in a single closed circuit, intake and discharge connections for said pump, a ported barrel, a spring-loaded plunger slidable and rotatable in the barrel, said barrel being connected with said connections, said plunger being subjected to fluid pressure created by the pump in said barrel and having control portions co-operating with the barrel ports, manual means for turning the plunger thereby to vary effective leak-off through said ports, the said leak-off being also dependently varied automatically by the plunger as the plunger slides towards a position controlling minimum

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fuel admission to enable greater percentage run-up at lower speeds with respect to the run-up at higher speeds and means connected with the intake and discharge connections of said pump for maintaining a constant pressure difference between the suction and delivery sides of said pump.

9. A fluid operated governor according to claim 8, one end portion of the plunger being grooved to provide the control edges that co-operate with the leak-off ports formed in the plunger barrel, and the other end portion serving as a balance plunger.

10. A fluid operated governor according to claim 8, one end portion of the plunger being grooved to provide the control edges that co-operate with the leak-off ports formed in the plunger barrel, and the other end portion serving as a balance plunger, and a damping restriction included in the fluid supply to said balance plunger to prevent building up of longitudinal vibrations of the control plunger.

11. In a fluid operated governor for variable speed engines the combination of a displacement pump adapted to be driven at a speed proportional to that of the engine for volumetrically pumping fluid in proportion to the speed of the engine in a single closed circuit, and having intake and discharge connections, with said intake connection connected to the engine fuel supply system, a double ended cylinder enclosing a spring-loaded control plunger subjected to the fluid pressure created by the pump under the control of a manually variable leak-off orifice for the fuel, means for automatically modifying the response of the spring-loaded plunger at a particular part of the engine speed range thereby to bring about greater percentage run-up at lower speeds with respect to the run-up at higher speeds, said means operating dependently on the control of the manually variable leak-off orifice, and means connected with said intake connection for effecting continued supply of fuel to the displacement pump in case of failure of fuel supply to the engine thereby to assure operation of the governor until the engine stops.

12. A fluid operated governor according to claim 11, the last recited means comprising a combined fuel reservoir and air-separator having an upper outlet leading to the engine and a lower outlet leading to the intake connection of the governor displacement pump, whereby if due to air leak into the fuel supply system the fuel level in the reservoir falls below the said upper outlet the engine will be starved but the contents of the reservoir will keep the governor supplied and operating properly until the engine stops.

13. A fluid operated plunger according to claim 11, including means precluding accumulation of air in the governor fluid system.

14. A fluid operated governor according to claim 11, the last recited means comprising a combined fuel reservoir and air-separator having an upper outlet leading to the engine and a lower outlet leading to the governor displacement pump, whereby if due to air leak into the fuel supply system the fuel level in the reservoir falls below the said upper outlet the engine will be starved but the contents of the reservoir will keep the governor supplied and operating properly until the engine stops, and an air vent from the highest point of the governor supply system beyond the leak-off orifice back to the separator thereby to preclude the possibility of air accumulating in the system.

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15. In a fluid operated governor for variable speed engines the combination of a displacement pump adapted to be driven at a speed proportional to that of the engine for volumetrically pumping fluid in proportion to the speed of the engine in a single closed circuit intake and discharge connections for said pump, a double ended cylinder supplied with fluid pressure through said connections, a spring-loaded control plunger operating in said cylinder and subjected to the fluid pressure created by the pump under the control of a manually variable leak-off orifice for the fluid, means for automatically modifying the response of the spring-loaded plunger at a particular part of the engine speed range thereby to bring about greater percentage run-up at lower speeds with respect to the run-up at higher speeds, and means connected in parallel with said intake and discharge connections for rendering the speed control of the governor independent of variations in the pressure at which fluid is fed thereto.

16. A fluid operated governor for variable speed engines having a torque controlling member in which the operating fluid is circulated in a single closed circuit by a displacement pump driven at a speed proportional to that of the engine, including a main governor spring, a circuit comprising a pump, a spring-loaded release valve adapted to maintain a substantially constant pressure across the pump and a double acting plunger having opposite end connections wherein the pressure at the upstream side of the valve is applied to one end of said double-acting plunger, while the pressure on the downstream side of the release valve is applied to the other end of the double-acting plunger and manually operated variable means for adjusting the speed setting of the governor, the difference of pressure on the two ends of the double-acting plunger being balanced by said main governor spring, and the plunger being connected to the torque-controlling member of the engine whereby movement of the double-acting plunger towards the end subject to pressure upstream of the release valve reduces the torque exerted by the engine.

17. A fluid operated governor for variable speed engines in which the operating fluid is circulated in a single closed circuit by a displacement pump driven at a speed proportional to that of the engine, including a single member comprising a spring loaded plunger and a manually variable orifice consisting of a ported barrel and spring loaded plunger provided with control grooves adapted to cooperate with the ports in the barrel, the combination constituting the manually variable orifice and the flow taking place from the interior of the barrel outwards through the ports, the effective area of which is controlled by rotating the plunger manually while it is left free to slide axially under the combined influence of the fluid pressure and the spring load on the plunger.

18. A fluid operated governor for variable speed liquid fuel engines in which the operating fluid is circulated in a single closed circuit by a displacement pump driven at a speed proportional to that of the engine, including a common chamber for feeding both said engine and said circuit, the circuit including a pressure sensitive spring loaded plunger, and a manually variable orifice, characterized by the fact that the governor uses engine fuel as its working fluid and that the said fluid is drawn from said common chamber to feed both the governor circuit and the engine, such supply to the governor being taken from a point

in the chamber lower than that from which the supply to the engine is drawn, so that in the event of a failure of the fuel supply, the engine shall be starved and brought to rest before the governor is rendered inoperative through loss of its working fluid.

19. In a system for hydraulically controlling speed of a variable speed engine, a single closed circuit path for operating fluid, a variable speed engine including a torque-controlling member disposed in said path, said path including a pumping member whose output is proportional to the speed of the engine to be controlled, a metering member disposed in series in said closed circuit, and means coupling said metering member with said torque-controlling member and operative to control the stability of said engine at the upper end of the speed range thereof and correct the inherent instability of the engine at low speed.

GEORGE WILFRID ACLAND GREEN. 20

JAKUB BUJAK.

RICHARD ERNEST RUTHERFORD.

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