Nov. 25, 1958 N. M. REINERS 2,861,559

GOVERNOR CONTROLLED ENGINE

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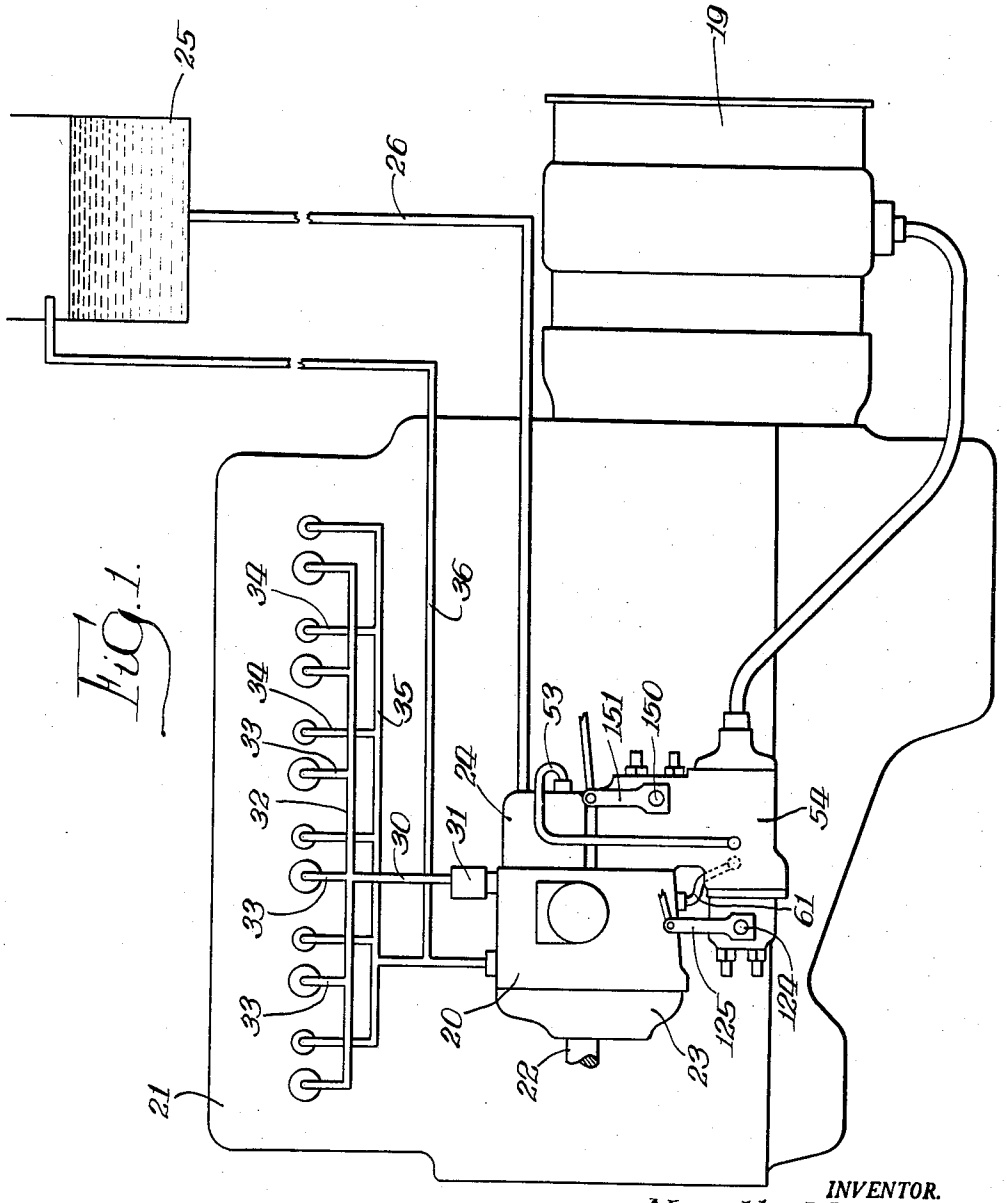


Fig. 1.

INVENTOR.
Neville M. Reiners,
BY

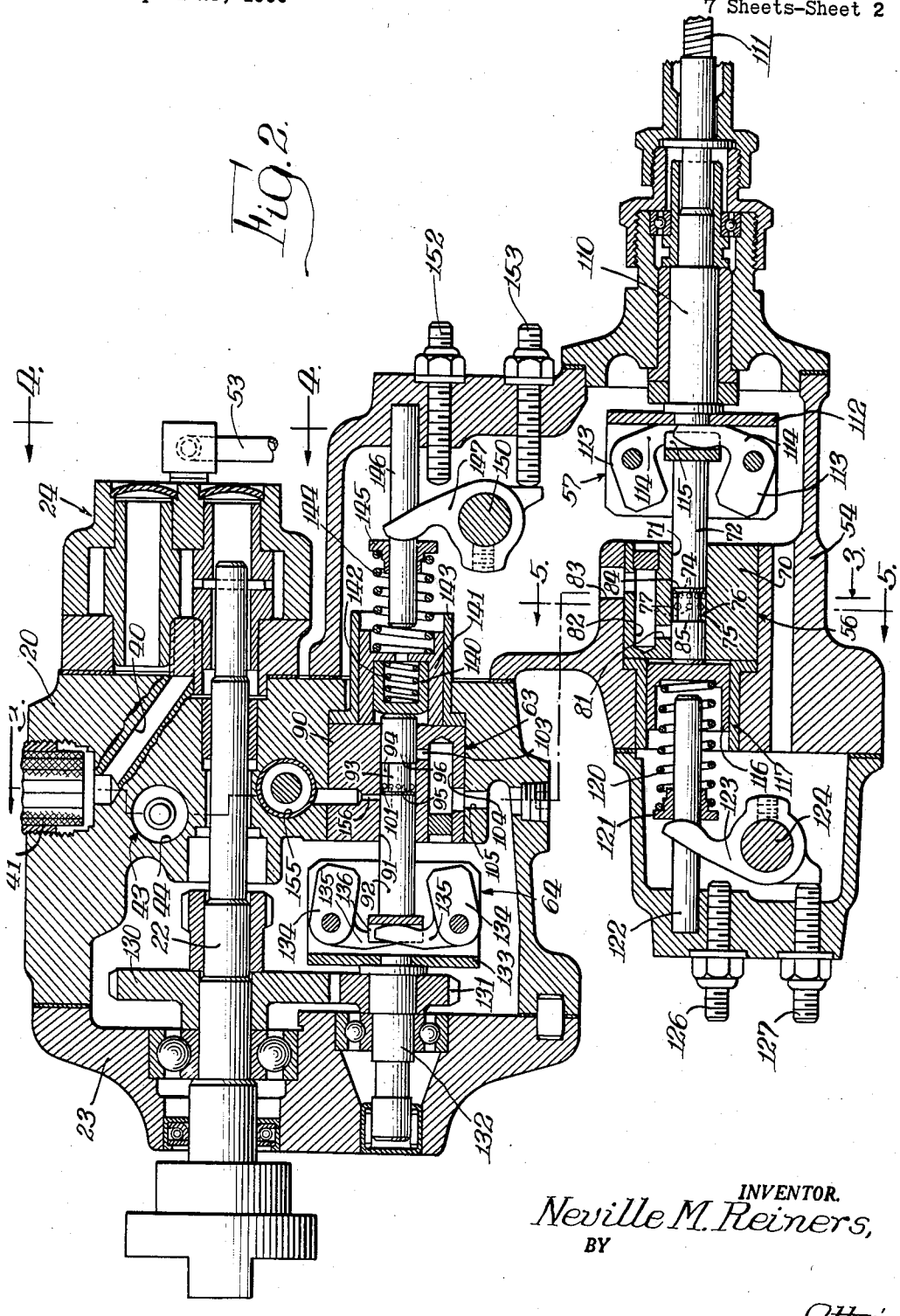
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GOVERNOR CONTROLLED ENGINE

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FIG. 2.



INVENTOR.
Neville M. Reiners,
BY

Atty's.

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GOVERNOR CONTROLLED ENGINE

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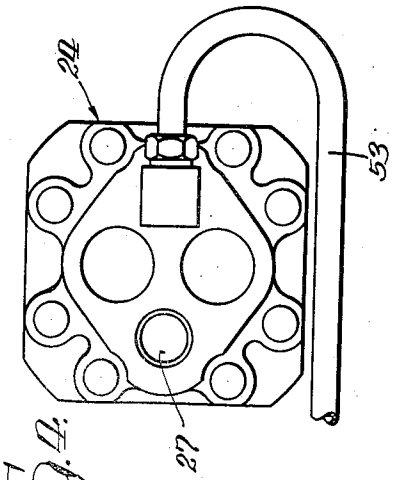


Fig. 4.

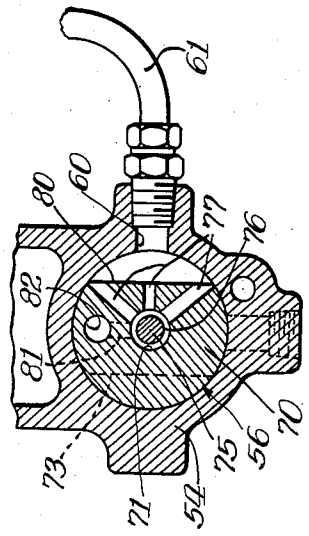


Fig. 5.

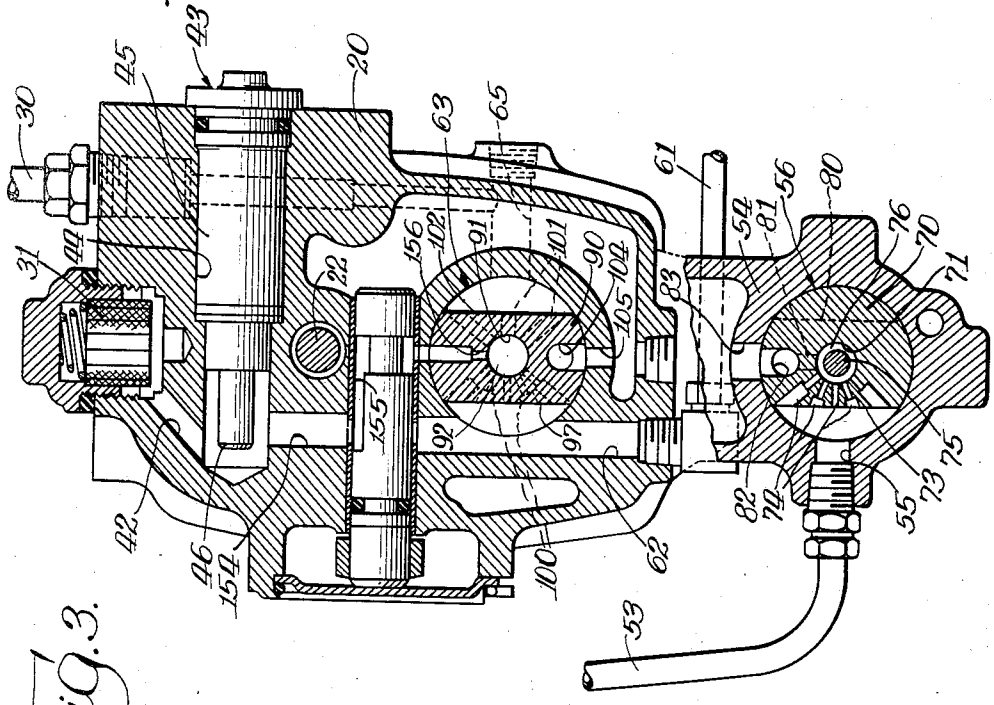


Fig. 3.

INVENTOR.
Neville M. Reiners,
BY

Atty's.

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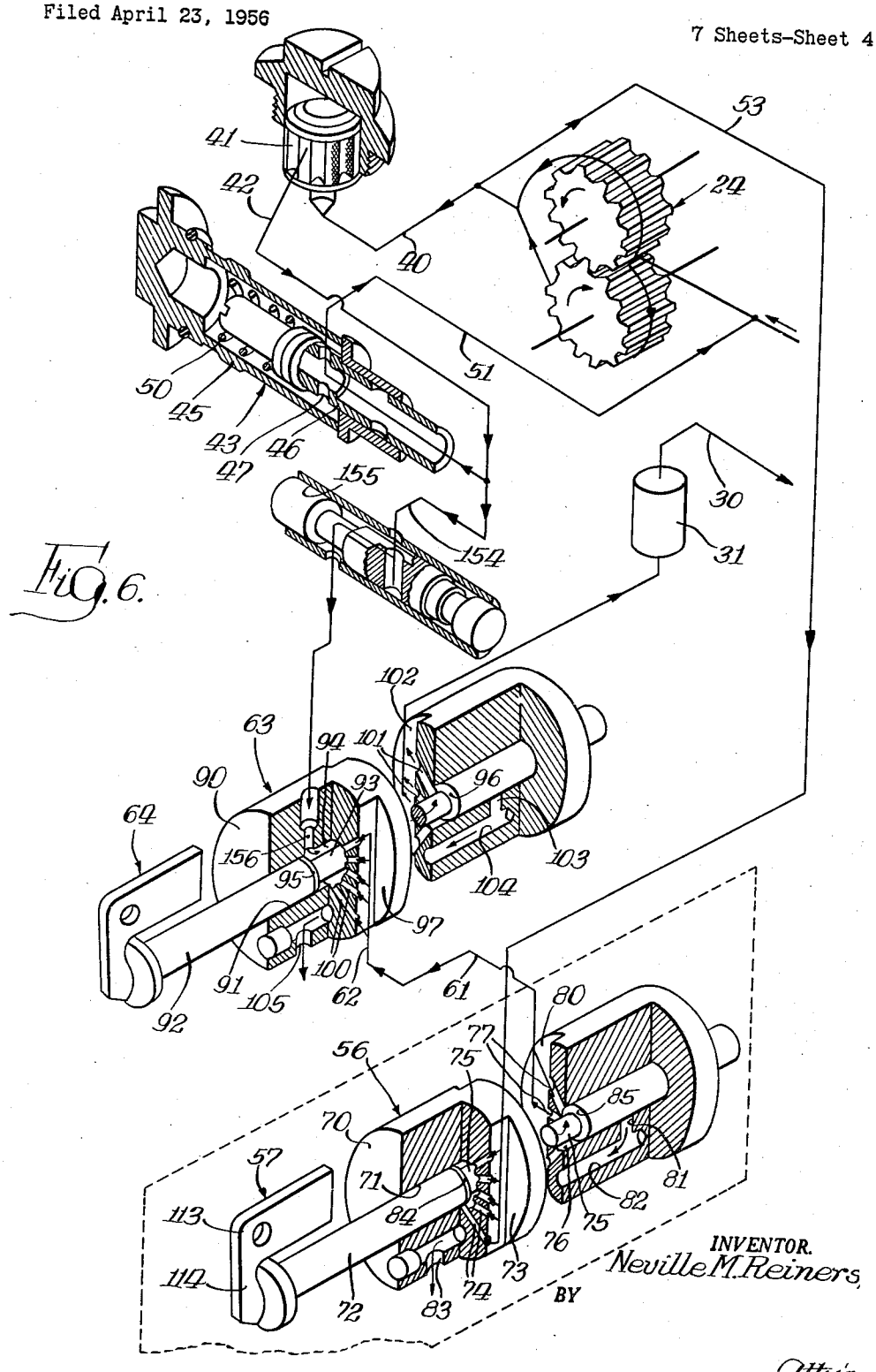


Fig. 6.

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Fig. 7.

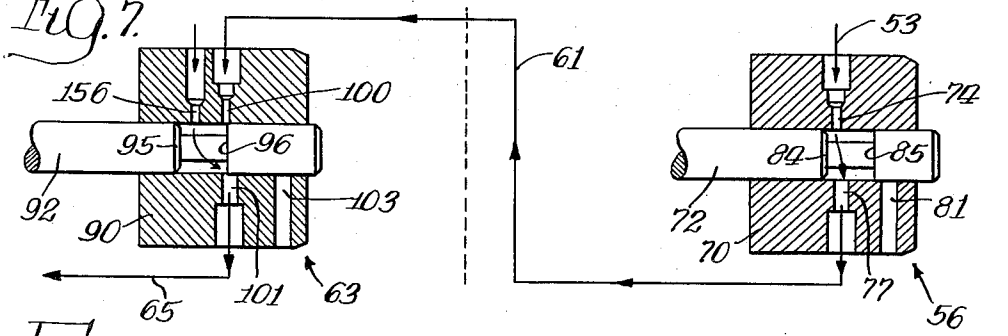


Fig. 8.

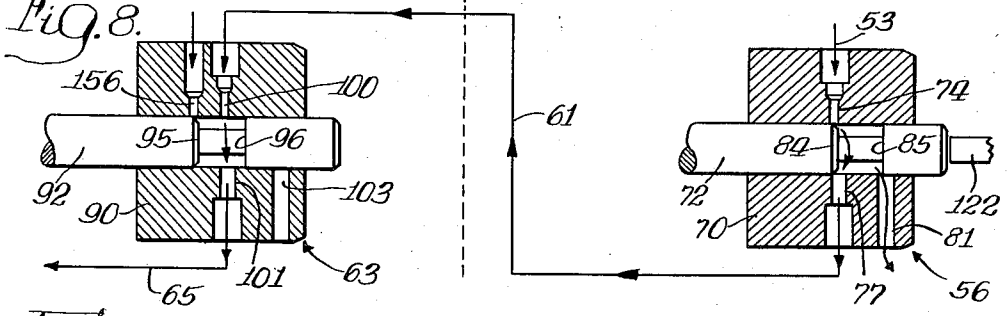


Fig. 9.

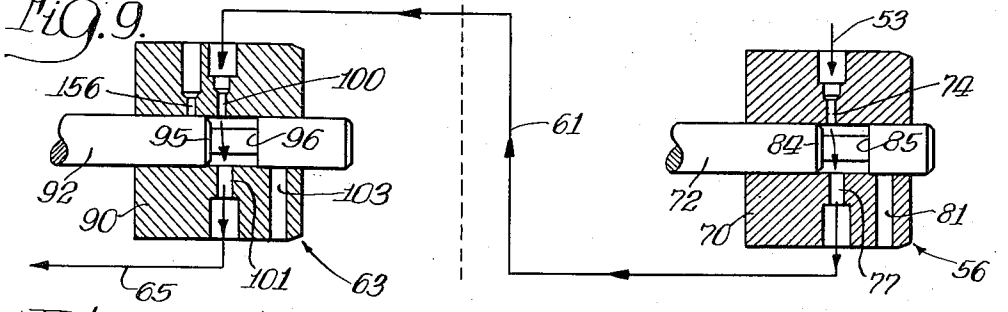
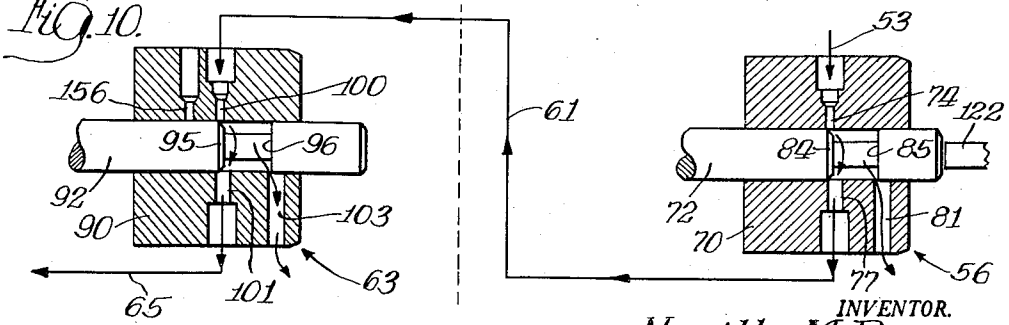


Fig. 10.



INVENTOR.
Neville M. Reiners,
BY

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Fig. 13.

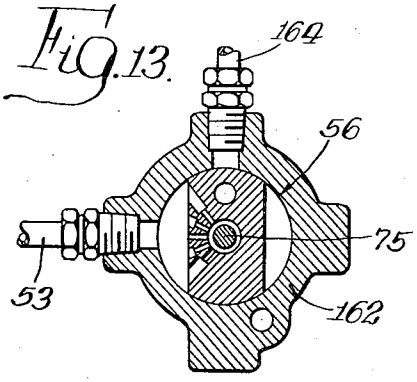
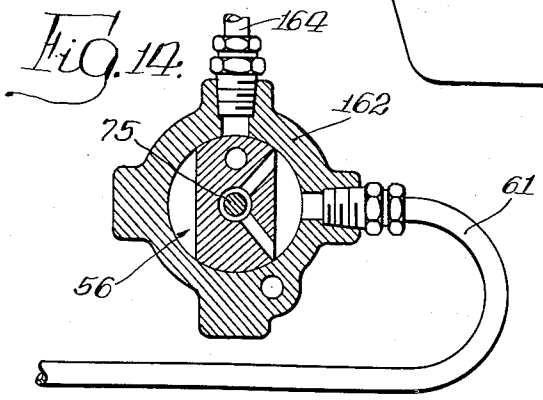


Fig. 11.

Fig. 14.



INVENTOR.
Neville M. Reiners,
BY

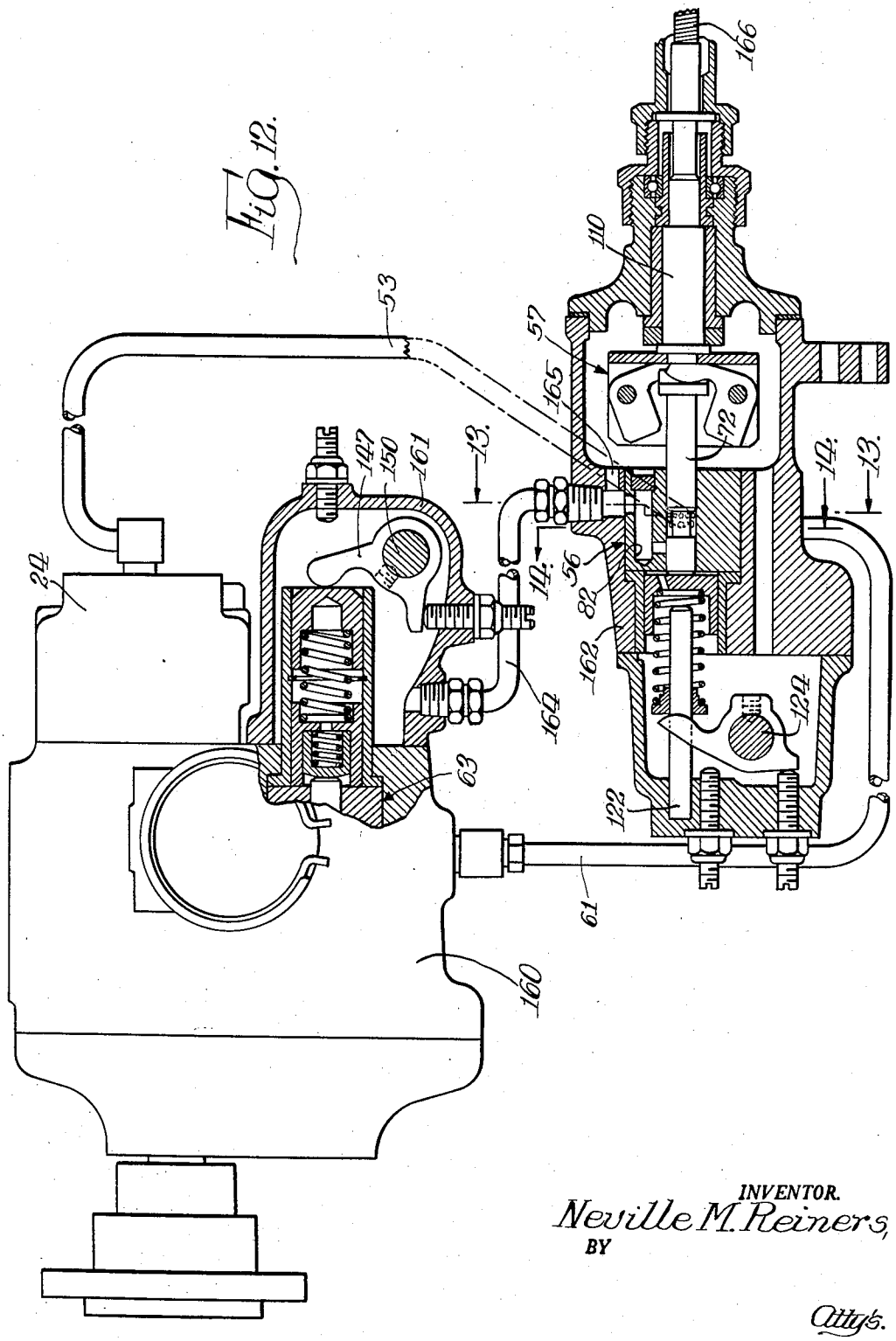
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Fig. 12.



INVENTOR.
Neville M. Reiners,
BY

Attys.

United States Patent Office 2,861,559 Patented Nov. 25, 1958

2,861,559

GOVERNOR CONTROLLED ENGINE

Neville M. Reiners, Columbus, Ind., assignor to Cummins Engine Company, Inc., Columbus, Ind., a corporation of Indiana

Application April 23, 1956, Serial No. 580,051

10 Claims. (Cl. 123—108)

The invention relates generally to governor controlled engines and more particularly to a governor controlled internal combustion engine.

The general object of the invention is to provide an engine and a mechanism driven thereby, and to control the engine in a novel manner both in response to operating characteristics of the engine and in response to operating characteristics of the mechanism driven thereby.

Another object is to provide an engine and a mechanism driven thereby, and a novel control means for the fuel supply of the engine, including a pair of control members serially arranged in the fuel supply line leading to the engine, with one control member responsive to operating characteristics of the engine and the other control member responsive to the operating characteristics of the mechanism driven thereby.

A further object is to provide an engine and a mechanism driven thereby and a novel control means of the foregoing character, which, when the control member responsive to said mechanism prevents flow of fuel, permits flow of fuel through a different path under the control of the control member responsive to the engine, so that the engine can properly idle.

More specifically, it is an object to provide an internal combustion engine, a torque convertor driven by the engine, and a pair of governors for normally controlling the flow of fuel to the engine, one governor being responsive to the engine speed and the other governor responsive to the speed of the output shaft of the torque convertor, with flow of fuel permitted under the sole control of the engine governor for operation of the engine at idle speed so that the torque convertor governor cannot override the engine governor to reduce the engine speed below such idle speed.

Still another object is to provide an internal combustion engine, a torque convertor, and governor control means of the foregoing character, in which the two governors may be made as a single unit preferably mounted adjacent the engine, or in which the two governors may be made as separate units with one mounted adjacent the engine and the other adjacent the torque convertor, with suitable connections therebetween.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a side elevational view of an engine provided with governing means, embodying the features of the invention;

Fig. 2 is a longitudinal vertical sectional view of the governing means shown in Fig. 1;

Fig. 3 is a transverse sectional view taken substantially on the line 3—3 of Fig. 2;

Fig. 4 is an end elevational view of a portion of the governing means as seen from line 4—4 of Fig. 2;

Fig. 5 is a fragmentary transverse sectional view taken on the line 5—5 of Fig. 2;

Fig. 6 is a diagrammatic view of the governing means;

Figs. 7 to 10, inclusive, are fragmentary diagrammatic views of portions of the governing means and showing the parts in different conditions of operation;

Fig. 11 is a view similar to Fig. 1 but showing a modified form of governing means;

Fig. 12 is a vertical sectional view of two parts of the governing means shown in Fig. 11;

Fig. 13 is a transverse sectional view taken on the line 13—13 of Fig. 12; and

Fig. 14 is a transverse sectional view taken on the line 14—14 of Fig. 12.

It is common practice, in the use of an engine, to provide governing means for controlling the speed of the engine, with the governing means responsive to the speed of the engine. Such engines are used to drive other mechanism and, because of changes of load on the engine due to the requirements of such mechanism, the speed of the engine will be altered. The governing means on the engine, however, in such instances will act to bring the speed of the engine to the desired point for the condition in the engine then existing.

There are some instances, however, when the governing means on the engine will tend to hold the speed thereof at a point which is excessive for desirable operation of the mechanism driven by the engine under the particular load conditions then existing. One instance of this kind is where an internal combustion engine is used to drive a torque convertor, which in turn operates equipment such as a crane, a hoist, and particularly when used to operate a power shovel. When the load on such piece of equipment is very light and the output shaft of the torque convertor tends to attain a very high rotative speed, overheating and other adverse effects in the torque convertor may occur. The engine speed, of course, in such instance is controlled by the engine governing means and tends to remain substantially the same as when a load is placed on the torque convertor and the output shaft of the latter is operated at a lower speed.

When such light load conditions are encountered, it is desirable to be able to reduce the governed speed of the engine so that the output shaft of the torque convertor will thereby be held to a more moderate speed and the convertor will thus avoid being overheated. It is, therefore, advisable not only to provide for control of the engine in response to its own operating speed, but also to provide a control superimposed upon the first-mentioned control, by which the engine may be caused to operate at a speed suitable for conditions existing in the torque convertor. Similar conditions may occur in the operation of an electric generator by an engine, where it may be desirable to control the engine, not only in response to its own speed, but also in response to the power output of the generator, measured in volts and amperes. In the case of a pump driven by an engine, it may be advantageous to control the engine not only in response to its own speed, but also in response to the pressure or delivery of the pump. Another instance may be in the case where temperature is a limiting condition for a mechanism driven by the engine, and in such case a control sensitive to such temperature condition may be superimposed upon the governing means for the engine.

The present embodiment of the invention is shown in connection with an internal combustion engine preferably of the diesel type, driving a torque converter, and comprises an engine-driven governor and a second governor driven by the output shaft of the torque converter. The two governors actuate valves which are in series in the conduit supplying fuel to the engine. Thus, when the output shaft of the torque converter rotates at an

excessive speed, it will reduce or shut off the flow of fuel to the engine through such conduit, even though the engine-driven governor calls for more fuel. The governor driven by the output shaft of the torque converter thereby overrides the effect of the engine driven governor, and the engine speed will be held to the point where the output shaft of the torque converter will not be driven at an excessive speed.

Under some abnormal conditions of operation, the governor driven by the output shaft of the torque converter may completely shut off the flow of fuel through its valve, and these conditions might continue until the engine speed fell to the point where the engine would stall. It is, therefore, desirable to provide a flow of fuel to the engine solely under the control of the engine governor to operate the engine at idling speed so that the torque converter governor cannot override the engine governor to lower the speed of the engine below such idling speed. To this end, a second conduit is provided to supply fuel directly to the valve controlled by the engine-driven governor for operation of the engine at idling speed, thus by-passing the torque converter governor.

Both of the valves controlled by the respective governors include drain passages which are adapted to be opened when the governors are driven at excessive speed, such drain openings providing for dumping of fuel and quick release of pressure in the conduit so that the engine will be quickly responsive to the governors. When the torque converter governor shuts off the flow through its valve and opens its drain passage, such dumping of fuel might withdraw some of the fuel supply intended for the engine supply through the second conduit for idling and thus would not permit delivery of full idle fuel to the engine. The valve controlled by the torque converter governor is, therefore, provided with a stop which limits the drainage that can occur through this valve so that the fuel supplied to the valve operated by the engine driven governor for idling will not be diverted through the drain but will be available for operating the engine at full idling speed.

The fuel supply apparatus illustrated in the drawings is similar to that disclosed in my Patent No. 2,727,498 issued December 20, 1955. Thus, it is shown as comprising a casing structure **20** (see Fig. 1) adapted to be mounted on the side of an engine **21** of the diesel type which drives a torque converter **19**. The apparatus includes a drive shaft **22** mounted in the casing structure and journalled in a cover **23** secured to one side of the casing structure. The shaft **22** is adapted to be driven from the crankshaft of the engine. Mounted on the opposite side of the casing **20** is a gear pump, indicated generally at **24**, driven by the shaft **22**. Fuel is supplied to the pump from a tank **25** (see Fig. 1) through a supply line **26**, the latter being connected to the pump at **27** (see Fig. 4).

Fuel under pressure supplied by the pump **24** is carried to the engine **21** by conduit means, and the flow therethrough is controlled as hereinafter described. The conduit means includes a line **30** (see Figs. 1 and 6) extending from the casing **20** and leaving a shut-off valve **31** provided therein. The line **30** is connected to a fuel inlet manifold or common rail **32** which, in turn, is connected by branch inlet lines **33** to the respective injectors (not shown) of the engine. Fuel returned from the injectors flows through branch return lines **34** to a drain manifold **35** which returns the fuel to the tank **25** through a drain line **36**. The interior of the main casing **20** is also connected to the line **36** so that fuel collecting in the interior of the main casing will be returned to the tank **25**.

The discharge of the pump **24** is connected by a passage **40** (see Figs. 2, 3 and 6) formed in the casing **20**, to a filter **41** mounted in the casing. The filter **41** in turn is connected by a passage **42** in the casing **20** to a pressure regulator indicated generally at **43**. The pressure regulator **43** is mounted in a bore **44** formed in the casing and comprises a tubular sleeve **45** (see Fig. 6) having a reduced portion at one end, which slidably supports a plunger **46**. The plunger **46** is closed at its inner end and extends outwardly beyond the sleeve **45** at its other end and is open to receive fuel supplied to the bore **44** through the passage **42**. The plunger **46** is provided with radial openings **47** which lie within a portion of the sleeve **35** and are closed thereby when no pressure is applied to the fuel entering the plunger. When the fuel supplied thereto is under pressure, plunger **46** is moved to the left, as shown in Fig. 6, against the pressure of a spring **50** to expose the radial openings **47** and permit fuel to drain therethrough. The fuel draining through the openings **47** is returned to the inlet side of the pump **24** through suitable passages formed in the casing **20** and illustrated diagrammatically at **51** in Fig. 6.

The operation of the pressure regulator **43** and its function in controlling the pressure of the fuel delivered by the pump **24** is fully explained in said patent. Broadly, the function of the pressure regulator is to vary the pressure of the fuel delivered by the pump to the engine to obtain the desired torque curve for the engine.

As heretofore stated generally, the pump **24** is adapted to supply fuel to the engine through a conduit means which includes two valves in series, with the valves controlled by governors respectively driven by the output shaft of the torque converter and by the engine. In the present instance, the delivery side of the pump **24** has a line **53** connected thereto. Since the passage **40** in the casing, leading to the pressure regulator **43**, is also connected to the delivery side of the pump **24**, the pressure of the fuel delivered through the line **53** will be controlled by the pressure regulator. The line **53** extends to and enters a passage **55** formed in an auxiliary casing **54** secured to the main casing **20** so that the two casings form a single unit. Within the auxiliary casing **54** is a valve means, indicated generally at **56**, controlled by a governor, indicated generally at **57**, driven from the output shaft of the torque converter **19**.

From the valve means **56**, the fuel is discharged through a passage **60** in the auxiliary casing to a short pipe **61** connected to a passage **62** formed in the main casing **20**. Connected to the passage **62** is a valve means, indicated generally at **63**, controlled by a governor, indicated generally at **64**, driven from the shaft **22** and hence by the engine. From the valve means **63**, fuel flows through a passage **65** formed in the main casing and connected to the line **30** leading to the injectors of the engine. With this arrangement, the flow of fuel from the pump **24** is controlled by the valve means **56** actuated by the governor **57** driven from the output shaft of the torque converter, and by the valve means **63** actuated by the governor **64** driven by the engine, two valve means **56** and **63** being in series in the conduit means extending from the pump to the injectors of the engine.

In the preferred construction, the valve means **56** comprises a cylindrical valve body **70** rigidly mounted in the auxiliary casing **54** and having a central bore **71** in which a valve plunger **72** is mounted for longitudinal movement to control the flow of fuel through the valve. To this end, the valve body **70** is provided with a slot **73** formed in one side of its periphery and communicating with the passage **55**, and a plurality of radial holes **74** are drilled in the body to extend from the slot **73** to the bore **71** therein. Within the bore **71**, the valve plunger **72** is provided with a reduced portion **75** which provides an annular space **76** within the bore **71** communicating with the radial holes **74** when the valve plunger **72** is properly positioned.

The valve body **70** is also provided with another set of radial holes **77** spaced longitudinally a short distance (see Fig. 2) from the holes **74** and extending outwardly

from the bore 71 on the opposite side of the bore from the holes 74. The holes 77 open into a slot 80 in the periphery of the valve body 70. The passage 60 in the auxiliary casing 54 extends from the slot 80 in valve body 70. Thus, fuel supplied by the pump 24 through the line 53 may flow through the slot 73, the holes 74, the annular space 76, the holes 77 and the slot 80 to the pipe 61, when the plunger 72 is suitably positioned.

The valve body 70 is further provided with a hole 81 extending radially from the bore 71 and longitudinally spaced from both the holes 74 and the holes 77. The hole 81 connects with a longitudinally extending hole 82 in the valve body and the latter hole connects with a radial opening 83 in the valve body and auxiliary casing extending to the interior of the auxiliary casing. The interior of the latter opens into the interior of the main casing 20 so that the pressures therein will be the same. The length of the reduced portion 75 of the plunger 72 is such that the holes 74 are closed by the shoulder 84 at one end of the reduced portion when the hole 81 is opened by the shoulder 85 at the other end of the reduced portion to dump fuel, as will hereinafter be explained, into the casing 54. Since the interior thereof communicates with the interior of the main casing 20, the dumped fuel will return to the tank 25 through the line 36.

The valve means 63 is constructed in a generally similar manner. Thus, it comprises a valve body 90 rigidly mounted in the main casing 20 and having a bore 91 extending therethrough. Mounted in the bore 91 is a valve plunger 92 having a reduced portion 93 providing an annular space 94 within the bore 91 and having shoulders 95 and 96 at its ends. The valve body 90 is provided with a slot 97 on its periphery, which communicates with the passage 62, and a set of radial holes 100 extend from the slot 97 to the bore 91. Also extending from the bore 91 is another set of holes 101 leading to a slot 102 in the valve body. The slot 102 connects with the passage 65 in the main casing and communicating with the injectors of the engine. The annular space 94 thus connects the holes 100 with the holes 101, so that, with both plungers 72 and 92 suitably positioned, fuel from pump 20 flowing in the line 53 will pass serially through the valve means 56 and 63 to the engine.

The valve means 63 is also provided with a dump passage comprising a radial hole 103 extending from the bore 91 in the valve body 90 and connected to a longitudinal hole 104. The latter connects with a radial opening 105 communicating with the interior of the main casing 20. The length of the reduced portion 93 of the valve plunger 92 is such that, when the shoulder 95 shuts off flow of fuel through the holes 100, the hole 103 will be placed in communication with the holes 101 to dump fuel from the lines extending to the injectors to increase the sensitivity of the governing action.

The two valve means 56 and 63, as heretofore mentioned, are controlled by devices respectively responsive to an operating characteristic of the mechanism driven by the engine and to the engine. In the present instance, the valve means 56 is responsive to the speed of the output shaft of the torque converter 19, while the valve means 63 is controlled by the engine speed so that the speed responsive governors 57 and 64 may be used for both valve means. The governor 57 comprises a drive shaft 110 (see Fig. 2) adapted to be connected to a flexible shaft 111 driven by the output shaft of the torque convertor 19 and journalled in radial and thrust bearings in the auxiliary casing 54. At its inner end, the shaft 110 is provided with a head 112 in which centrifugal weights 113 are pivotally mounted. The weights 113 are provided with arms 114 engaging on opposite sides of a tang 115 formed on one end of the valve plunger 72 to move the plunger longitudinally in response to the action of the weights 113 and to rotate the plunger to prevent any sticky action thereof.

At its other end, the plunger 72 is opposed by spring means comprising a cup-shaped member 116 bearing against the end of the plunger and slidable in a sleeve 117 mounted in the auxiliary casing 54. One end of a spring 120 is seated in the cup-shaped member 116 and the other end bears against a collar 121 slidably mounted on a rod 122 fixed in the auxiliary casing. To adjust the pressure of the spring 120 and hence the setting of the governor 57, a lever 123 engages the collar 121 and is mounted on a shaft 124 extending to the exterior of the auxiliary casing 54 where it carries a manually operable throttle lever 125 (see Fig. 1). The extent of adjustment of the throttle lever 125 and hence the spring 120 is determined by a low speed stop in the form of an adjustable screw 126 threaded in the auxiliary casing and engageable by the lever 123 and a high speed stop comprising an adjustable screw 127 also engageable by the lever 123 when moved in the opposite direction. The rod 122 also functions as a stop limiting movement of the cup-shaped member 116 for reasons hereinafter described.

The governor 64 is driven by the engine and for this purpose a gear 130 (see Fig. 2) is mounted on the shaft 22 which has a driving connection with the engine crank shaft. The gear 130 meshes with another gear 131 mounted on a shaft 132 journalled in the main casing 20. The shaft 132 has a head 133 at one end, pivotally supporting centrifugal weights 134, and the latter have arms 135 engaging a tang 136 on one end of the valve plunger 92 so that the plunger is rotated thereby and is moved longitudinally in response to the action of the centrifugal weights 134.

Longitudinal movement of the valve plunger 92 is opposed by spring means including a pair of springs, one functioning during idling of the engine and the other for speeds above idling. Thus, the other end of the valve plunger 92 bears against a cup-shaped member 140 slidably mounted in a sleeve 141. Seated within the member 140 is the idling spring, indicated at 142, which also bears against a transverse wall in the sleeve 141. The latter is slidably mounted in a second sleeve 143 fixed in the main casing 20. The sleeve 141 bears against the spring, indicated at 144, which functions at speeds above idling speed. The spring 144 also bears against a collar 145 slidably mounted on a fixed rod 146. To adjust the pressure of the spring 144 and hence the setting of the engine governor 64, a lever 147 engages the collar 145 and is mounted on a shaft 150 extending to the exterior of the main casing 20 and having an engine throttle lever 151 (see Fig. 1) mounted thereon. The extent of adjustment of the throttle lever 151 and hence the spring 144 is determined by a low speed stop comprising an adjustable screw 152 engageable by the lever 147 and a high speed stop comprising an adjustable screw 153 also engageable by the lever 147 when moved in the opposite direction. The rod 146 also functions as a stop limiting movement of the sleeve 141.

When the engine is operating at idle speed, the spring 144 holds the sleeve 141 against the valve body 90 with the spring 144 extended. Movement of the valve plunger 92 during idling merely effects compression and expansion of the spring 142, but when the engine speed exceeds idling, the cup-shaped member 140 engages the transverse wall of the sleeve 141 and the spring 144 then functions throughout the range above idle speed.

The engine is of course arranged to be operated at idle speed when desired, and the flow of fuel to the engine when idling is under the control of the engine-driven governor 64 and the valve means 63. However, if the supply of fuel to the engine during idling were also under the control of the governor 57 driven by the torque convertor, there could be conditions under which the valve means 56 would completely shut off the flow of fuel therethrough so that the engine would stall. Such conditions might arise, for example, with an engine for

driving a vehicle where the vehicle, in going downhill, would drive the torque convertor at an excessive speed and completely close the valve means 56.

For this reason, the flow of fuel to the engine during idling is solely under control of the engine-driven governor 64 and valve means 63 and cannot be affected by closing of the valve means 56. To this end, fuel is supplied to the valve means 63 for operation of the engine at idling speed through a second conduit. Thus, the bore in the main casing 20 in which the pressure regulator 43 is mounted and to which fuel is supplied by the passage 42 is connected by a passage 154 (see Figs. 2 and 6) to a bore 155 in the main casing 20. The main casing 20 and the governor 64 with its valve means 63 and the other elements mounted thereon is of a construction employed in drives which do not have the torque convertor 19 driven by the engine, and the bore 155 is provided to receive a shiftable throttle valve. In this instance, such a throttle valve is not used and the bore 155 is closed by a member having a passage therethrough constituting a continuation of the passage 154 and leading to a radial hole 156 in the valve body 90. The radial hole 156 is spaced longitudinally from the holes 101 and is so positioned that the annular space 94 about the reduced portion 93 of the valve plunger 92 provides communication between the hole 156 and the holes 101 when the valve plunger 92 is at its idle speed position. Thus, the shoulder 95 on the valve plunger 92 controls the flow of fuel at idling speed by controlling the extent of opening of the hole 156, the shoulder 95 moving to open the hole 156 when the engine falls below idling speed and closing the hole 156 when the engine exceeds the idling speed.

Since the annular space 94 connects the hole 156 with the holes 101 leading to passages connected to the engine, fuel from the pump 24 may be supplied to the engine solely under the control of the governor 64 and its associated valve means 63. Thus, the torque convertor governor 57 and its associated valve means 56 cannot decrease the flow to the engine below that required when the engine is operating at idling speed. The torque convertor governor 57 may completely shut off the flow of fuel through the valve means 56 but when the engine speed is reduced to idling, the fuel supplied through the hole 156 under the control of the valve plunger 92 maintains operation of the engine at idling speed.

When valve plunger 72, under conditions of excessive speed of the output shaft of the torque convertor, opens the dump passage 81, the latter is connected to the holes 77 by the annular space 76 about the reduced portion 75 of the valve plunger 72, as heretofore mentioned. If this occurred when the engine was operating at idle speed and the dump hole 81 were fully opened for free flow therethrough, some of the fuel supplied through the hole 156 in the valve means 63 might be drained off instead of going to the engine. To prevent such bleeding, the stop provided by the rod 122 prevents the valve plunger 72 from opening the dump hole 81 fully and the hole 81 cannot be opened to the extent where bleeding would prevent sufficient fuel being supplied to the engine for operation at idle speed.

To illustrate the operation of the governing means herein disclosed, Figs. 7 to 10 diagrammatically show the position of the parts of the two valve means 56 and 63 under different conditions of operation. Thus, Fig. 7 illustrates the conditions existing when the engine is shut down. In this instance, both valve means 56 and 63 are open for the flow of fuel therethrough when the engine is started, the radial hole 156 in the valve means 63 for supplying fuel for idling being open at this time. When the engine is started, the engine-driven governor 64 will shift the valve plunger 92 first to the idling position illustrated in the left-hand portion of Fig. 8, with the shoulder 95 on the valve plunger 92 controlling the flow of fuel through the hole 156. Should the output shaft of the torque convertor 19 tend to reach an excessive speed, the flow through the valve means 56 will be shut off by the shoulder 84 of the valve plunger 72 closing the holes 74 as illustrated in the right-hand portion of Fig. 8, so that no fuel will flow to holes 100 in the valve means 63. Under this condition the flow of fuel to the engine through the hole 156 in the valve means 63 is adequate to maintain operation of the engine at idling speed. Thus, the shutting-off of fuel by the valve means 56 when the torque convertor overspeeds cannot cause the engine to stall.

As heretofore described, under this condition of overspeeding of the torque convertor, the opening of the dump hole 81 in the valve means 56 is prevented from bleeding fuel back through the holes 100 in the valve means 63 to the valve means 56 to decrease the fuel supplied to the engine for idling. Prevention of such bleeding is accomplished by the stop 122 limiting movement of the valve plunger 72 so that the dump hole 81 is prevented from being opened to an extent that would permit such bleeding.

Under normal conditions of operation, the position of the parts is illustrated in Fig. 9. During such operation, fuel flows through the valve means 56 to the holes 100 in the valve means 63 and then to the engine. The engine of course is operating at a speed above idling so that the valve plunger 92 had shut off the flow through the idling hole 156. Should the load on the torque convertor be suddenly decreased and cause an excessive speed of the output shaft of the convertor, the valve plunger 72 will move to the position shown in the right-hand portion of Fig. 10 and will reduce the flow of fuel through the valve means 56 and thus override the engine governor to cause a reduction in engine speed. Conversely, if the conditions of operation of the torque convertor were such as to cause an undesirable increase in engine speed, the valve means 63 operated by the engine governor will control the flow of fuel to the engine by moving the valve plunger 92 to the position illustrated in the left-hand portion of Fig. 10 to limit the engine speed to a predetermined maximum as determined by the setting of the throttle lever 151.

In some installations because of space limitations, it may be desirable to position the torque converter governor and its associated valve means at some point remote from the engine driven governor and its valve means, so that the casing housing the former is separate and removed from the casing for the latter. In Figs. 11 to 14, I have shown such an arrangement. Thus, a main casing 160 is mounted on the side of the engine to house the governor 64 driven by the engine and its associated valve means 63. The spring means of the governor 64 and the lever 147 for adjusting the spring means are mounted within a cover structure 161 secured to the casing 160.

The governor 57 driven by the torque converter and its associated valve means 56 are, in this instance, housed in a casing 162 shown as mounted on a bracket 163 secured to the torque converter 19. The line 53 extending from the pump 24 is therefore connected to the casing 162, while the pipe 61 connecting the valve means 57 in series with the valve means 63, in this form, connects the casing 162 with the casing 160. Since, in the first-described form the interior of the auxiliary casing 54 and the interior of the main casing are connected so that they will be maintained at the same pressure and so that the fuel dumped into the auxiliary casing may be returned to the tank through the line 36, the casing 162 is connected to the casing 160 by a line 164. In the present instance, one end of the line 164 communicates with the dump hole 82 in the valve means 56 and with the interior of the casing 162 by a port 165 therein. At its other end, the line 164 is connected to the cover 161, the interior of which communicates with the interior of the casing 160. The governor 57 is shown as

being driven by a flexible cable 166 connected to the torque converter 19.

I claim:

1. The combination of an engine, mechanism driven by the engine, means providing a source of fuel under pressure, a pair of control devices for controlling the flow of fuel from said source to said engine, one of said devices being connected to said source and to the other device and being operable in response to an operating characteristic of said mechanism to control the flow of fuel to said other device, and said other device being connected to the engine and being operable in response to an operating characteristic of said engine to control the flow of fuel thereto, and a connection between said source and said other device for supplying fuel to said engine under the control of said other device alone when said engine is operating at idle speed and said one device shuts off flow of fuel therethrough.

2. The combination of an engine, mechanism driven by the engine, means providing a source of fuel under pressure, a conduit connecting said source with said engine for supplying fuel thereto, first and second valves in series in said conduit, means responsive to an operating characteristic of said mechanism for operating said first valve, means responsive to an operating characteristic of said engine for operating said second valve, and a second conduit extending from said source to said second valve for supplying fuel to said engine under the control of said second valve when said engine is operating at idle speed and said first valve is closed.

3. The combination of an engine, mechanism driven by the engine, means providing a source of fuel under pressure, a conduit connecting said source with said engine for supplying fuel thereto, first and second valves in series in said conduit, means responsive to an operating characteristic of said mechanism for operating said first valve, a governor responsive to the speed of said engine for operating said second valve, and a second conduit extending from said source to said second valve for supplying fuel to said engine solely under the control of said governor when said engine is operating at idle speed and said first valve is closed.

4. The combination of an engine, mechanism driven by the engine, means providing a source of fuel under pressure, a conduit connecting said source with said engine for supplying fuel thereto, first and second valves in series in said conduit, a pair of governors respectively responsive to the speed of said mechanism and the speed of said engine for operating the respective valves, and a second conduit extending from said source to said second valve for supplying fuel to said engine under the control of the governor responsive to engine speed when said engine is operating at idle speed and the governor responsive to the speed of said mechanism closes said first valve.

5. The combination of an engine, a torque converter driven by the engine and having an output shaft, means providing a source of fuel under pressure, a conduit connecting said source with said engine for supplying fuel thereto, a first valve in said conduit, a second valve in said conduit between said first valve and the engine, a first governor responsive to the speed of said output shaft for operating said first valve, a second governor responsive to the speed of said engine for operating said second valve, and a second conduit extending from said source to said second valve for supplying fuel to said engine under the control of said second governor when said engine is operating at idle speed and said first governor closes said first valve.

6. The combination of an engine, mechanism driven by the engine, an engine-driven pump for delivering fuel under pressure, a pair of conduits branching from the delivery side of said pump, a pressure-responsive valve in one of said conduits for by-passing fuel to the intake side of said pump to control the pressure of the fuel in both of said conduits, a first valve in one of said conduits, means responsive to an operating characteristic of said mechanism for operating said first valve, a second valve connected to receive fuel from both of said conduits and connected to the engine, and a governor responsive to the speed of the engine for operating said second valve, said second valve when said engine is operating at idle speed and said first valve closes the conduit in which it is located receiving fuel from the other conduit.

7. The combination of an engine, mechanism driven by the engine, an engine-driven pump for delivering fuel under pressure, a first conduit connecting said pump with said engine for supplying fuel thereto when said mechanism is under load, a first valve in said conduit, means responsive to an operating characteristic of said mechanism for operating said mechanism, a second valve in said conduit between said first valve and the engine, governor means responsive to the speed of the engine for operating said second valve, a second conduit extending from said pump to said second valve for supplying fuel to the engine for operating the engine at idling speed when said first valve is closed, and a pressure-responsive valve in said second conduit for by-passing fuel to the intake side of said pump to control the pressure of the fuel in both of said conduits.

8. The combination of an engine, mechanism driven by the engine, means providing a source of fuel under pressure, a first conduit connecting said source with said engine for supplying fuel thereto, first and second valves in series in said conduit, means responsive to an operating characteristic of said mechanism for operating said first valve and adapted to close said first valve when said operating characteristic exceeds a predetermined value, said first valve having a drain passage adapted to be opened when the first valve is closed, an engine-driven governor for operating said second valve in response to engine speed, and a second conduit extending from said source to said second valve for supplying fuel to the engine under the control of said second valve for operating the engine at idling speed when said first valve is closed, said drain passage in said first valve being adapted to be connected to said second valve when said first valve is closed to reduce the pressure of fuel in said second valve for quickly reducing the speed of the engine to idling speed.

9. The combination of claim 8 wherein a stop is provided to limit the opening of said drain passage to insure sufficient flow of fuel to the engine through said second valve for operation of the engine at idling speed.

10. The combination of an engine, mechanism driven by the engine, means providing a source of fuel under pressure, a first conduit connecting said source with said engine for supplying fuel thereto, first and second valves in series in said conduit, said first valve comprising a valve body having a bore, and inlet, outlet and drain passages extending radially from said bore, and a valve plunger mounted in said bore having a reduced portion to connect said inlet and outlet passages and close said drain passage when in one position and to connect said outlet and drain passages and close said inlet passage when in a second position, means responsive to an operating characteristic of said mechanism for shifting said plunger and adapted to move said plunger to said second position when said operating characteristic exceeds a predetermined value, said second valve comprising a valve body having a bore, and first and second inlet passages and an outlet passage, and a valve plunger in said last mentioned bore having a reduced portion to connect all of said passages of said second valve when in one position and to close said second inlet passage and connect said first inlet and said outlet passages when in a second position, an engine-driven governor for shifting said plunger in response to engine speed, and a second conduit extending from said source to said second inlet passage of said second valve for operating said engine

at idling speed, the movement of the plunger of said first valve to its second position thereby connecting said drain passage of said first valve with the first inlet passage and the outlet passage of the second valve when the inlet passage of the first valve is closed to reduce the pressure of fuel at the engine for quickly reducing the speed of the engine to idling speed.

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