

Sept. 8, 1936.

C. SCHAEER

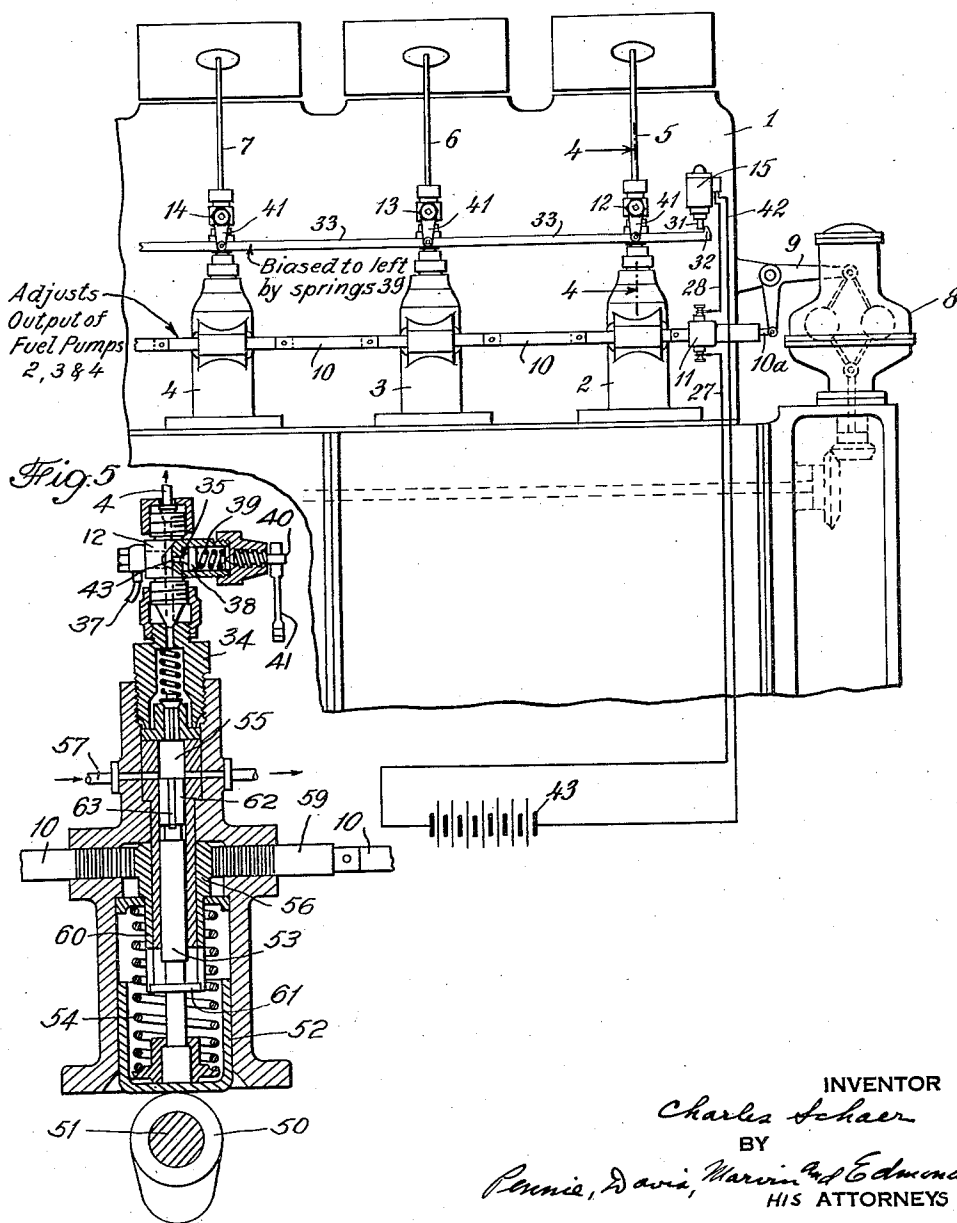
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GOVERNING APPARATUS FOR INTERNAL COMBUSTION ENGINES

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2 Sheets-Sheet 1

Fig. 1,



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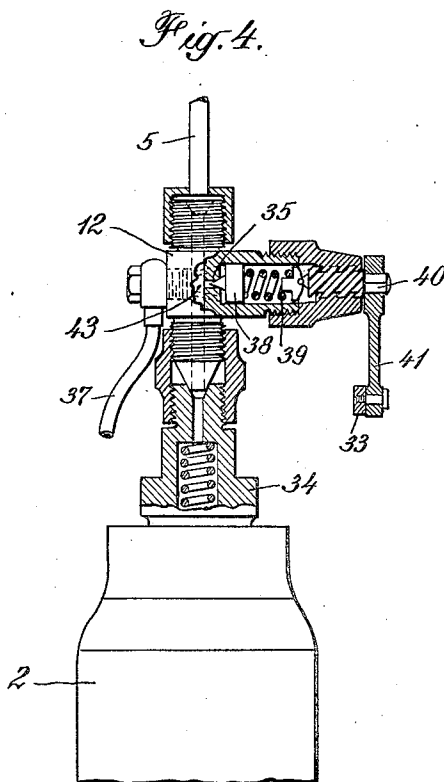
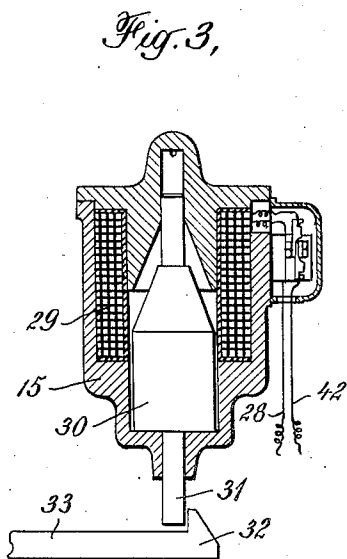
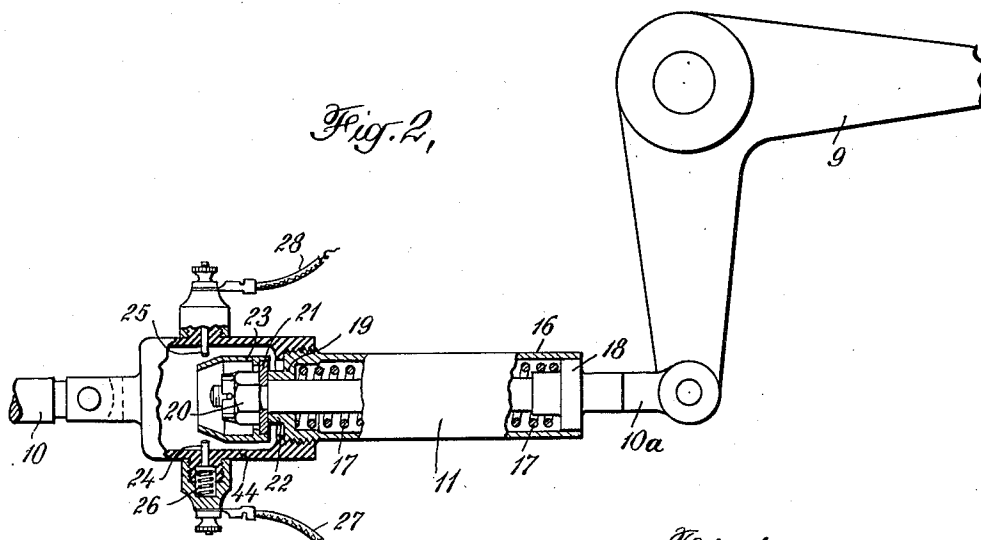
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2 Sheets-Sheet 2



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GOVERNING APPARATUS FOR INTERNAL COMBUSTION ENGINES

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5 Claims. (Cl. 123—140)

The present invention relates to the regulation or control of internal combustion engines, particularly multi-cylinder engines.

In internal combustion engines of the kind where separate devices, such, for example, as pumps, are provided to supply the fuel to each cylinder of the engine, the engine governor being arranged to vary the outputs of these individual devices for the purpose of regulating the engine speed and power output, should one of these devices get out of order, the force required to be exerted by the governor to change the output of such device is usually increased. This interferes with the proper operation of the governor so that it is unable to maintain the speed of the engine at the desired value.

In order to keep the engine operating when a fuel supplying device gets out of proper operating condition, it has heretofore been proposed to insert a yielding device in the connection between the engine governor and each individual fuel supplying device. Then, should any of the fuel supplying devices become jammed, or damaged, or otherwise get out of order, the other fuel supplying devices would be continued in operation, thereby keeping the engine running.

There are, however, two disadvantages to this arrangement. In the first place, the force necessary for operating the yielding device is added to the normal force exerted by the governor in changing the outputs of the fuel supplying devices, or in other words, the "setting" of the governor is changed, so that the desired speed of operation of the engine is no longer maintained by the governor. This creates a serious situation where the internal combustion engine is driving an alternating current generator connected to an alternating current distributing system to which other generators are also connected. In addition, the engine still continues in operation after the damage occurs to the fuel pump with the result that the pump is apt to be damaged, and in some instances is completely destroyed. Further damage results from the fact that foreign particles produced by the damage or destruction of the fuel pump are apt to be carried along with the fuel into the injection nozzle and into the engine cylinders. There is liability of the engine also being damaged by such foreign particles getting into the other fuel pumps, and likewise causing them to be damaged.

In addition to these disadvantages, with internal combustion engines provided with governing mechanism as above described, the change of setting of the governor caused by the addi-

tional force required to operate an improperly operating fuel pump, has the effect (upon the power load on the engine being reduced) of causing the speed of the engine to increase to an extent which is liable to damage the engine. In other words, the engine is apt to be allowed to race, and thereby be subjected to the injuries which are liable to occur on account of excessively high engine speed.

Accordingly it is the primary object of the present invention to provide a governing apparatus which will protect the engine against the occurrence of excessive speed, should one or more of the engine fuel pumps become jammed or otherwise get out of order in such a way as to increase the operating force required of the governor.

Another object of the invention is to provide a governing apparatus which, in the event of damage to a fuel pump, will stop the engine and thus save the fuel pump from being damaged beyond repair, or destroyed, by continuing it in operation after the damage occurs.

The invention will be understood from a consideration of the accompanying drawings in which there is illustrated by way of example one embodiment of the invention shown in simplified form, and also from consideration of the following description.

In these drawings:

Fig. 1 is a side elevation of the right hand end portion of a multi-cylinder internal combustion engine with the governing apparatus of the present invention applied thereto, the engine being shown more or less diagrammatically.

Fig. 2 is a view partly in elevation and partly in section showing in detail the construction of one of the members of the governing apparatus.

Fig. 3 is an enlarged vertical section of a relay forming a part of the governing apparatus.

Fig. 4 is a view, partly in elevation and partly in central vertical section, of the upper end of one of the fuel pumps and showing the construction of one of the fuel by-pass valves, and

Fig. 5 is a vertical sectional view illustrating the details of the fuel pumps as shown in Fig. 1.

Referring now to these drawings, the engine 1 is provided with separate or individual fuel pumps for supplying fuel to each of the engine cylinders. Three of the cylinders have been illustrated in Fig. 1 and these are supplied respectively by means of fuel pumps 2, 3 and 4. The pistons of these pumps are driven in any suitable manner (not shown) by the engine 1 so as to supply fuel to the injection valves of the engine at the proper times through the fuel pipes, or conduits 5, 6 and 7.

The speed of the engine is controlled by means of a governor 8. Governor 8 acts through an angle lever 9 and a longitudinally slidable rod 10 to adjust the regulating devices of each of the fuel pumps 2, 3 and 4, thereby varying the quantity of fuel delivered by each of the fuel pumps, that is, the output of each of these pumps, with variations in the engine speed, so as to maintain the speed constant within the range of operation of the governor regardless of the power output required of the engine. Thus, for example, a reduction in the power load on the engine will cause an increase in engine speed which, in turn, will cause the fly balls of the governor 8 to move outwardly from their center of rotation, thereby lowering the horizontal arm of angle lever 9. This causes a movement of rod 10 toward the left, which reduces the amount of fuel supplied by the fuel pumps. Movement of rod 10 toward the right causes the quantity of fuel supplied to the engine cylinders to be increased.

Although the regulating device for the fuel pumps 2, 3 and 4 can be of any suitable construction, a desirable construction is shown in Fig. 5 which illustrates the structural details of fuel pump 2. Pumps 3 and 4 are of similar construction. Referring to this figure, cam 50 of the cam shaft 51 lifts the cross head body 52 and plunger piston 53 against the force of spring 54, whereby the fuel contained in the pump chamber 55 is forced through pipe 4 and injected into the combustion chamber of the engine. The fuel is led from a supply tank to the pump through pipe 57, and a second pipe 58 is provided by means of which excess fuel is returned to the supply tank.

The longitudinally slidable rod 10, the movement of which adjusts or regulates the output of the fuel pump, is connected to a slidable rack 59, the teeth of which engage a pinion 56. On displacement of rack 59 by rod 10, pinion 56 is rotated together with sleeve 60 to which it is attached, and sleeve 60 being connected to pump plunger 53 by means of a pin 61 causes the pump plunger to be turned on its axis. This turning of the pump plunger causes the helicoidal running control edge 62 to uncover earlier or later in the stroke of the pump the opening leading to return pipe 58 so that a greater or lesser quantity of the fuel drawn into the pump chamber through pipe 57 can flow through groove 63 into the space below control edge 62 and thence to the outlet leading to return pipe 58.

With such a pump, under normal conditions, very little force is required of the governor to rotate the pump piston and change the output of the pump. Should an irregularity in operation occur, however, such, for example, as through particles of dirt from the fuel working in between the cylinder walls and the pump piston, the piston will begin to stick or jam. Under these conditions, the piston of such a pump no longer turns readily. This increases the force required by the governor 8 to move the adjusting rod 10, and the result of this jamming of one or more of the pump pistons, is that, upon a lightening of the load upon the engine, the governor attempts to reduce the amount of fuel supplied by the fuel pumps, but the shifting of rod 10 is prevented by the jammed pump, and the speed of the engine is apt to increase to a dangerous point.

To overcome this difficulty, the present invention provides the mechanism about to be described by means of which the governor 8, whenever the resistance to the adjustment of the regulating means of the fuel pumps exceeds a prede-

termined force, causes the actuation of an auxiliary means for reducing the supply of fuel to the engine cylinders. The operation of such auxiliary means reduces the amount of fuel supplied to such an extent that the engine is either stopped, or at least the development of power by the engine is so diminished as to prevent the engine from operating at excessively high speed.

For the purpose of reducing the supply of fuel to the respective engine cylinders, by-pass valves 12, 13 and 14 are connected in the fuel pipes 5, 6 and 7 leading to the cylinders. These valves are actuated by arms or levers 41 which are pivoted at their lower ends to a common actuating rod 33. These valves are held in their normal or closed positions, shown in Fig. 1, by means of an electromagnetic relay 15, having a pin 31 attached to its core 30 which, in its normal position, engages an upwardly projecting head 32 on the end of actuating rod 33. When the operating coil 29 of relay 15 is energized, as will presently be described, pin 31 is lifted, releasing rod 33 which, being biased toward the left as will be described below moves in that direction and changes the adjustment of valves 12, 13 and 14 so that a portion, or all, of the fuel pumped by the fuel pumps 2, 3 and 4 is by-passed back to the fuel tank through conduits 37.

For the purpose of energizing relay 15, the device 11, shown in detail in Fig. 2, is connected between the right hand end of rod 10 and the vertical arm of angle lever 9. This device comprises a sleeve 16 within which is a spring 17, which at one end bears against a collar 18 formed on a rod-like member 10a, by which device 11 is connected to angle lever 9, and at the other end on a seat 19 which forms a part of sleeve 16. A disc 21 is mounted against a shoulder on the left hand end of rod-like member 10a by means of a nut 20, this disc being held against a stop 22 (formed as an extension of seat 19) by the tension of spring 17.

Spring 17 is held between collar 18 and seat 19 under a predetermined initial tension, so that disc 21 is held against stop 22 with a definite pressure which corresponds to the maximum force to be exerted by governor 8 in moving rod 10 for the purpose of adjusting the regulating devices of fuel pumps 2, 3 and 4 to vary the outputs thereof.

On disc 21 there is also arranged a member 23 having a cone-shaped end, and when spring 17 is compressed, this conical end moves toward the left and makes contact with two pins 24 and 25 which are mounted in member 44 which is constructed of insulating material. The movement of member 23 forces these outwardly against their positioning springs 26. In this way, a circuit is completed from battery 43 through conductors 27 and 28 to relay 15 and back to the battery through conductor 42.

The construction of valves 12, 13 and 14 is shown in Fig. 4. These valves are mounted upon the tops of the fuel pumps 2, 3 and 4, respectively. They are provided with a longitudinal passage-way 43 by means of which fuel from the pumps is led to the conduits 5, 6 and 7. Opening laterally at the center of the valve is a small passage which is closed by valve 35 which is mounted on the inner end of a valve-supporting member 38 which is arranged to slide freely within a cylindrical bore in the valve casing. Valve 35 is urged toward the left by means of a helical spring 39, the tension of which is adjustable by turning a valve spindle 40 which is threaded into the outer end of the valve casing by a high pitched double

left hand thread. The arms 41 are fixed to the outer ends of spindles 40 and when these arms are turned to the vertical position in which they are normally held by relay 15, springs 39 are compressed so that the pressure exerted by them on the respective valve-members 35 of valves 12, 13 and 14 is sufficient to prevent these valves from opening during the operation of the fuel pumps 2, 3 and 4. Hence, under normal conditions, the fuel from these pumps is forced through conduits 5, 6 and 7 into the engine cylinders.

The pitch of the double threads on spindles 40 is sufficiently high so that when the right hand end of rod 33 is released by the energization of relay 15, springs 39 turn the spindles and arms 41 together with rod 33 toward the left. This permits the inner ends of spindle 40 to move outwardly a sufficient distance to release the tension of springs 39 so that valve members 35 are permitted to open, thereby allowing at least a portion of the fuel supplied by pumps 2, 3 and 4 to be by-passed through the dotted passages shown in Fig. 4 to discharge pipe 37 which may return this by-passed fuel to the fuel supply tank.

In the operation of the improved governing apparatus, so long as the fuel pumps 2, 3 and 4 are in good operating condition, the adjusting forces transmitted by the governor 8 through angle lever 9, device 11 and rod 10 do not exceed the predetermined amount for which spring 17 of device 11 is set. However, when one of the fuel pumps begins to jam, as for example, by the presence of dirt, or other particles, between the pump plunger and cylinder walls, the forces required for adjusting the output of the pump by the governor are increased when the engine operates at a speed which differs from its normal operating speed, because the governor strives to adjust the regulating devices of the fuel pumps, but is prevented by the jammed pump from effecting a proper adjustment.

The jamming of a pump becomes particularly dangerous when, in consequence of the relieving of the power load on the engine, its speed rises excessively. Then a pressure towards the left (Fig. 1) is exerted on rod 10 by governor 8. However, on account of the jammed pump, rod 10 does not move under the increased adjusting force exerted by the governor, and consequently cone-shaped member 23 of device 11 is moved toward the left against the action of spring 17, so that contact is made with pins 24 and 25. This closes the circuit through relay 15 as above described, and releases rod 33 so that the valve arms 41 move toward the left as shown in Fig. 1 under the action of springs 39. This movement simultaneously reduces the tension on valves 35 and permits fuel to flow back to the fuel tank through pipes 37 instead of being forced into the engine cylinders. This causes the engine to be stopped, or at least so reduces its output as to prevent an excessive rise in speed.

It will be understood that the above is merely an exemplifying disclosure of the invention in connection with one embodiment thereof, and that various changes may be made without departing from the spirit of the invention. Thus, for example, various types of fuel pumps may be employed so long as the fuel outputs of the several pumps can be regulated by a common governor. Also, the fuel pumps may be constructed as separate units, or they can be assembled in block form. It is essential, however, that each engine cylinder be supplied with fuel from its

own fuel pump. In like manner, changes may be made in the construction of the by-pass valves, and if desired, these valves can be made to completely stop the flow of fuel to the engine cylinders. Furthermore, although electromagnetic means have been shown for causing the operation of by-pass or cut-off valves 12, 13 and 14, it will be understood that the invention includes the actuation of these valves by other means, it being intended that the scope of the invention shall be indicated by the appended claims.

I claim:

1. In a multi-cylinder internal combustion engine the combination of a plurality of fuel pumps, one for supplying fuel to each of said cylinders, each of said pumps having a regulating device for varying the output thereof, a governor for controlling the speed of the engine, auxiliary means for reducing the fuel delivery of said fuel pumps, a connection between said governor and each of said pump regulating devices including yielding means adapted to be actuated only after the force exerted by said governor in operating said regulating device exceeds a predetermined maximum above normal, and means operatively connecting said yielding means, and said auxiliary means adapted, upon actuation of said yielding means, to operate said auxiliary means to reduce the fuel delivery to the engine.

2. In a multi-cylinder internal combustion engine the combination of a plurality of fuel pumps one for delivering fuel to each of said cylinders, each of said pumps having a regulating device for varying the output thereof, a valve having an element permitting the by-passing of fuel from the delivery conduit of each of said fuel pumps, a relay having its armature operatively connected with said by-pass valve elements to hold them in closed position, a governor for controlling the speed of said engine, a connection between said governor and said fuel pump regulating devices including means for closing a circuit through said relay upon an increase in the force exerted by the governor to actuate said regulating devices above normal, so as reduce the fuel supply to the engine cylinders in the event that a fuel pump becomes jammed.

3. In an internal combustion engine, the combination of means for regulating the fuel supply to the engine during normal operation thereof, a governor operated in accordance with the speed of the engine, means, including yielding means, connecting said governor with said fuel supply means and actuated by said governor for controlling the fuel supply to the engine, an auxiliary device for reducing the engine speed, and means operable only after the force exerted by the speed governor in operating said fuel supply means exceeds a predetermined maximum above normal and is sufficient to actuate said yielding means for actuating said auxiliary device.

4. In an internal combustion engine, the combination of means for regulating the fuel supply to the engine during normal operation thereof, a governor operated in accordance with the speed of the engine, means connecting said governor with said fuel supply means and actuated by said governor for controlling the fuel supply to the engine, an auxiliary device for reducing the engine output operable only after the force exerted by the speed governor in operating said fuel supply means exceeds a predetermined maximum above normal, and means actuated by said gover-

nor and forming a part of the means connecting the governor with the fuel supply means responsive to an increase above said predetermined maximum force for actuating said auxiliary device.

- 5 5. In an internal combustion engine, the combination of means for regulating the fuel supply to the engine during normal operation thereof, a governor operated in accordance with the speed of the engine, an electrical circuit including an
10 electrical device, means, including yielding means for closing said electric circuit, connecting said

governor with said fuel supply means and actuated by said governor for controlling the fuel supply to the engine, auxiliary means for reducing the engine speed, said electrical device preventing operation of said auxiliary means until the force exerted by the speed governor in operating said fuel supply means exceeds a predetermined maximum above normal and is sufficient to actuate said yielding means to close the circuit including said electrical device. 5 10

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