Sept. 1, 1942. B. LOEFFLER 2,294,469

INJECTION PUMP GOVERNOR

Filed Nov. 1, 1939 7 Sheets-Sheet 1

Fig. 1,

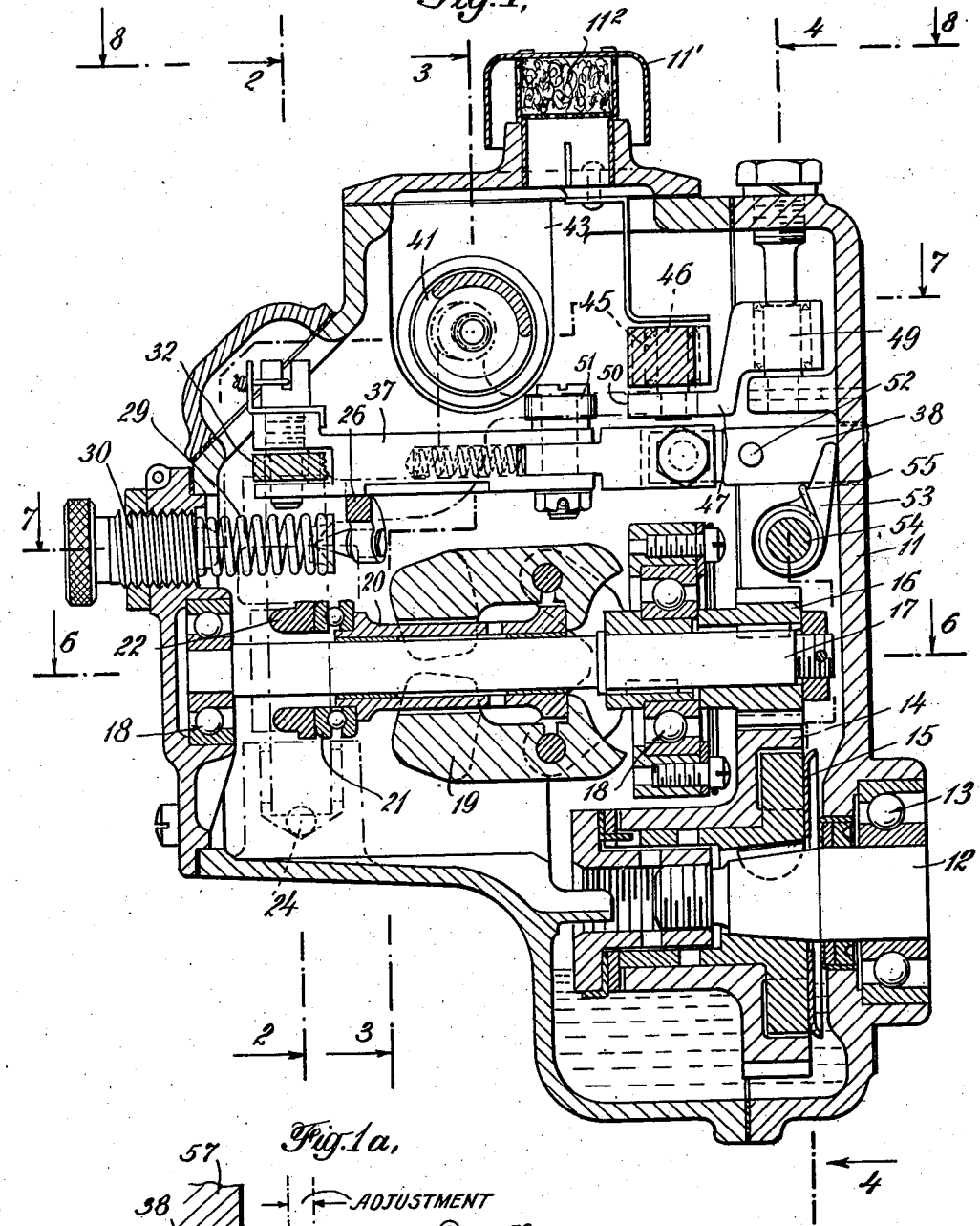
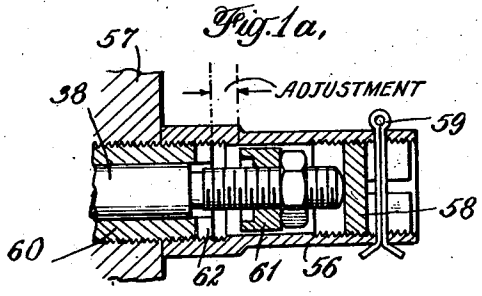


Fig. 1a,



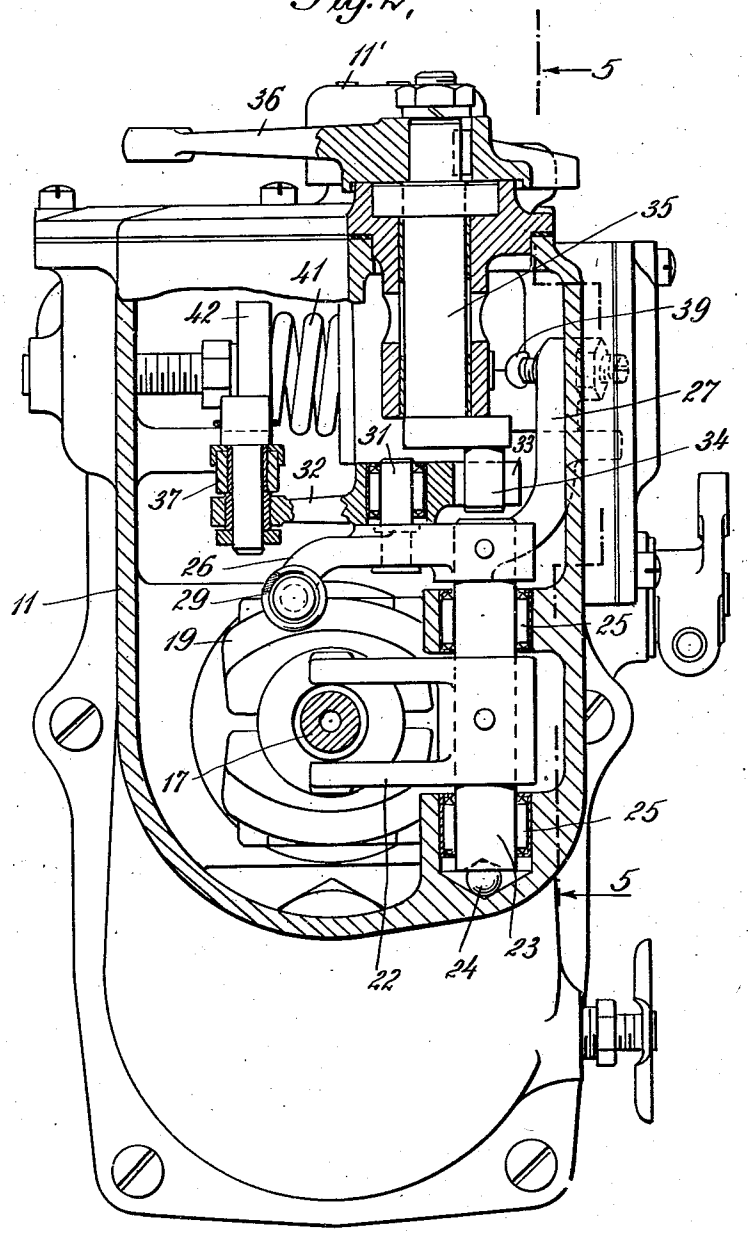
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Sept. 1, 1942. B. LOEFFLER 2,294,469

INJECTION PUMP GOVERNOR

Filed Nov. 1, 1939 7 Sheets-Sheet 2

Fig. 2.



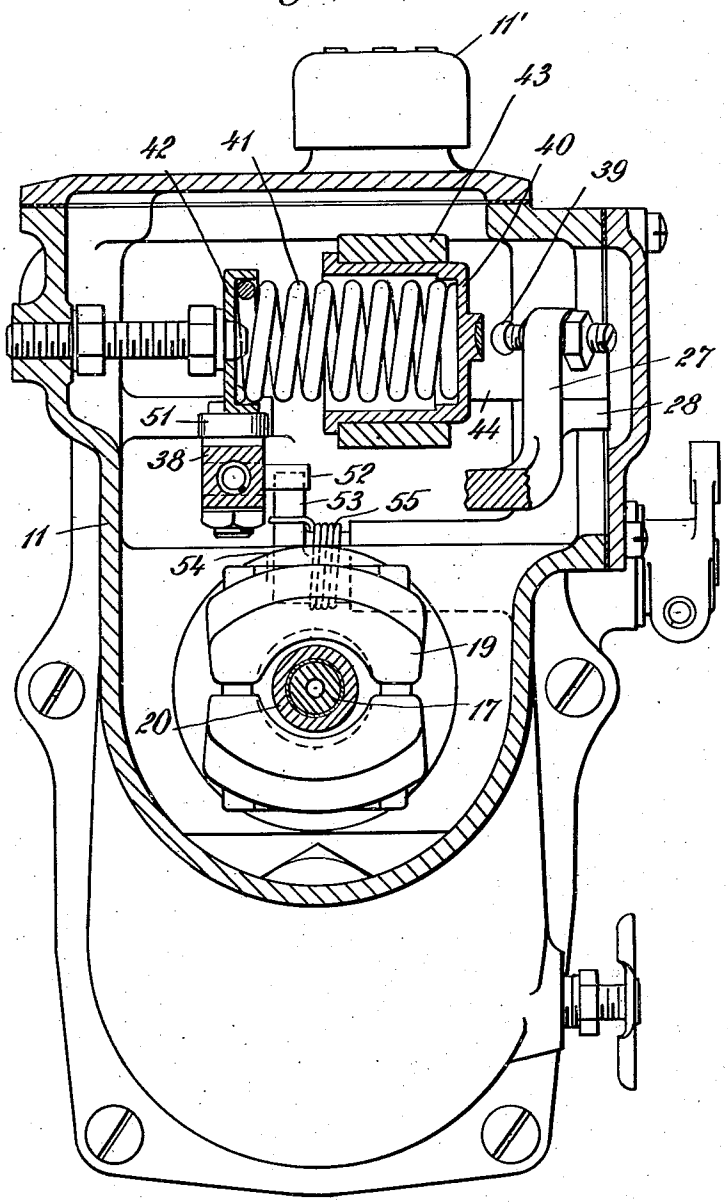
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INJECTION PUMP GOVERNOR

Filed Nov. 1, 1939 7 Sheets-Sheet 3

Fig. 3,



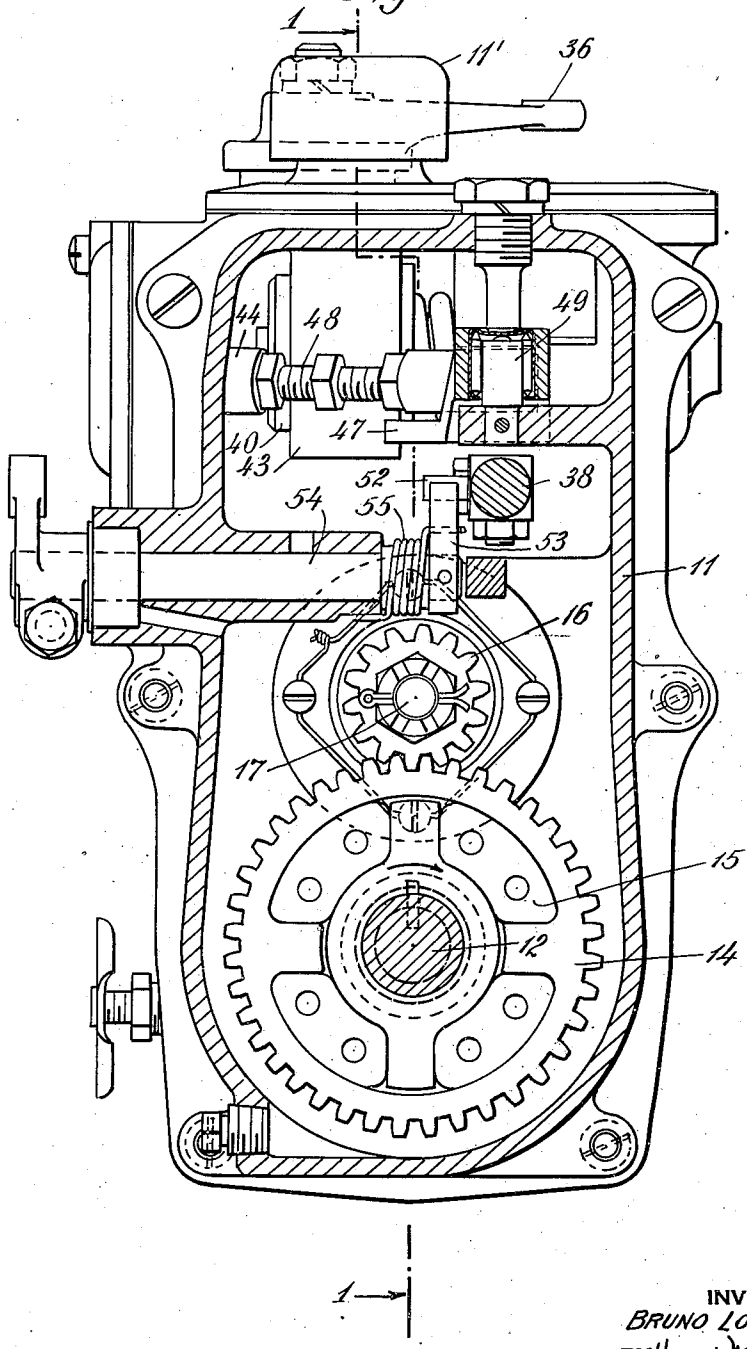
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Filed Nov. 1, 1939 7 Sheets-Sheet 4

Fig. 4



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INJECTION PUMP GOVERNOR

Filed Nov. 1, 1939 7 Sheets-Sheet 5

Fig. 5,

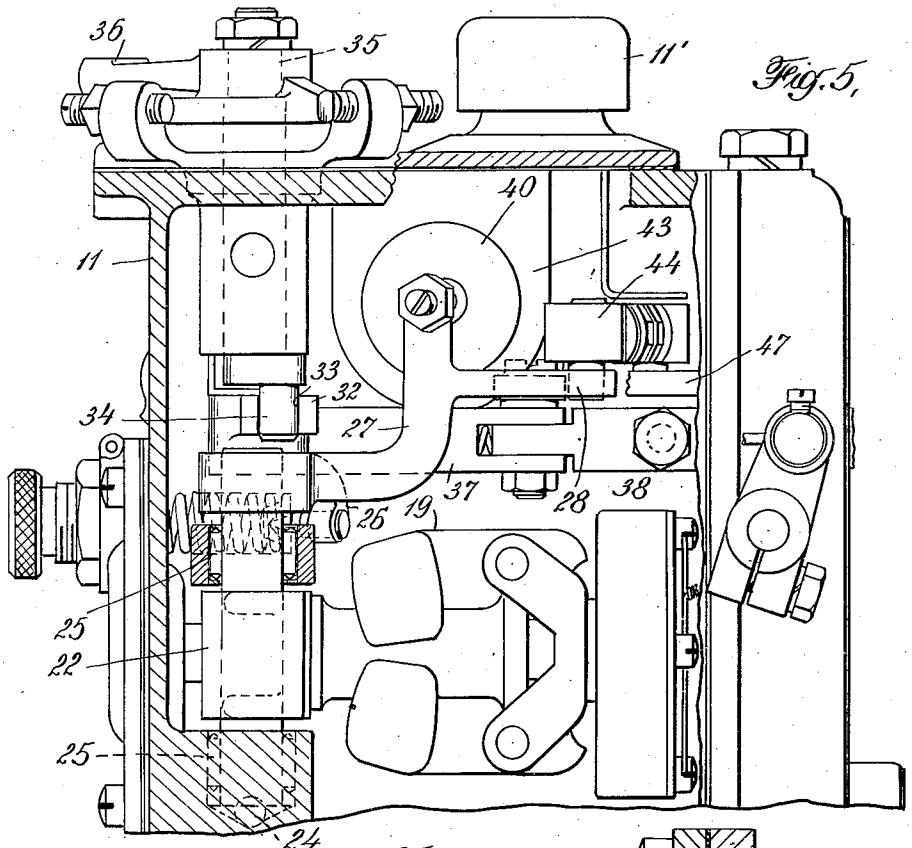
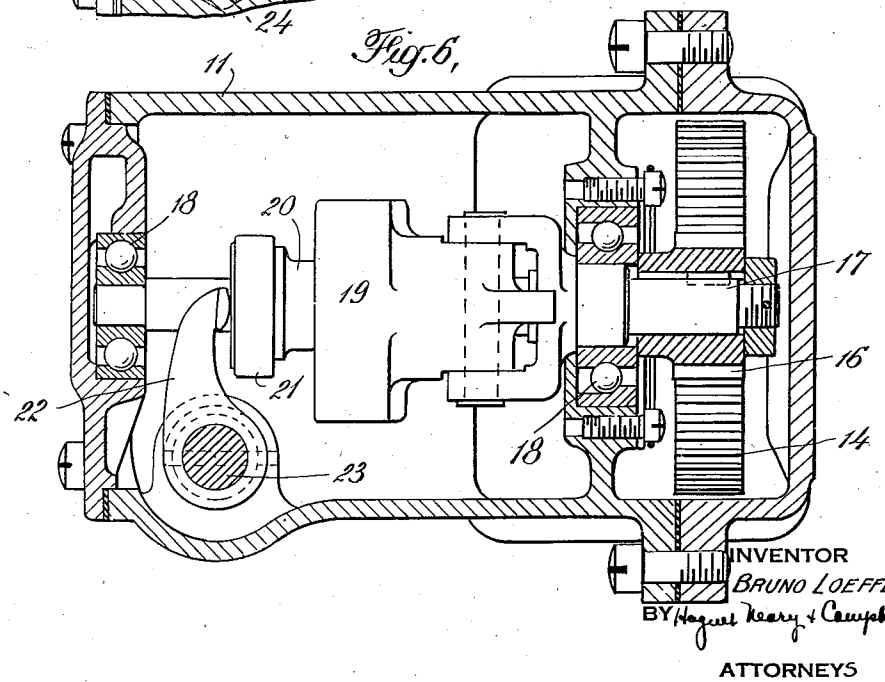


Fig. 6,



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INJECTION PUMP GOVERNOR

Filed Nov. 1, 1939 7 Sheets-Sheet 6

Fig. 7,

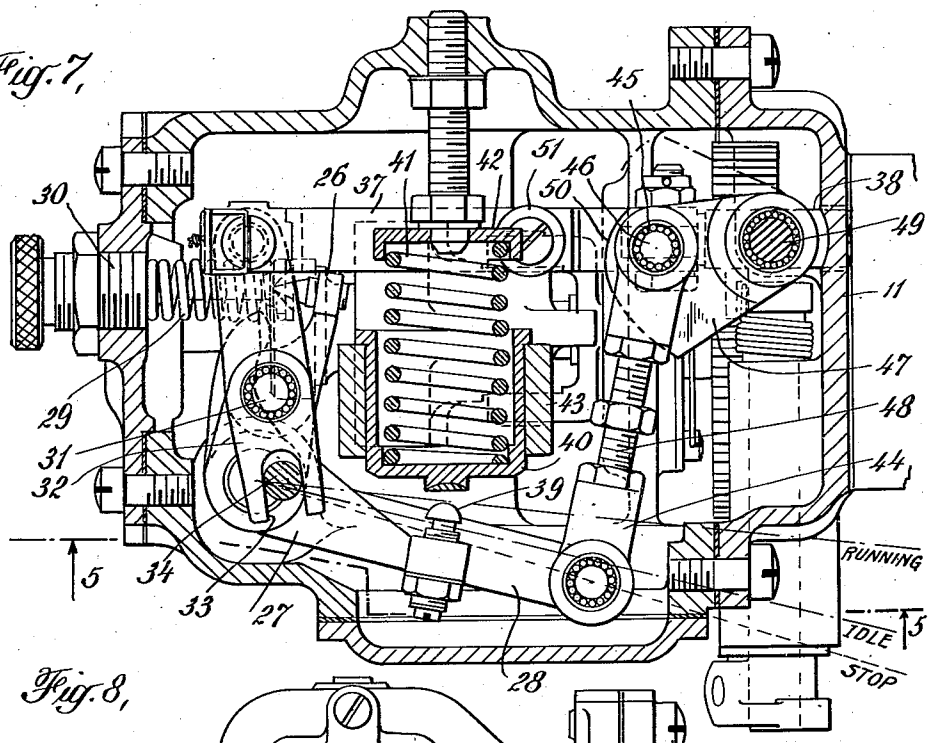
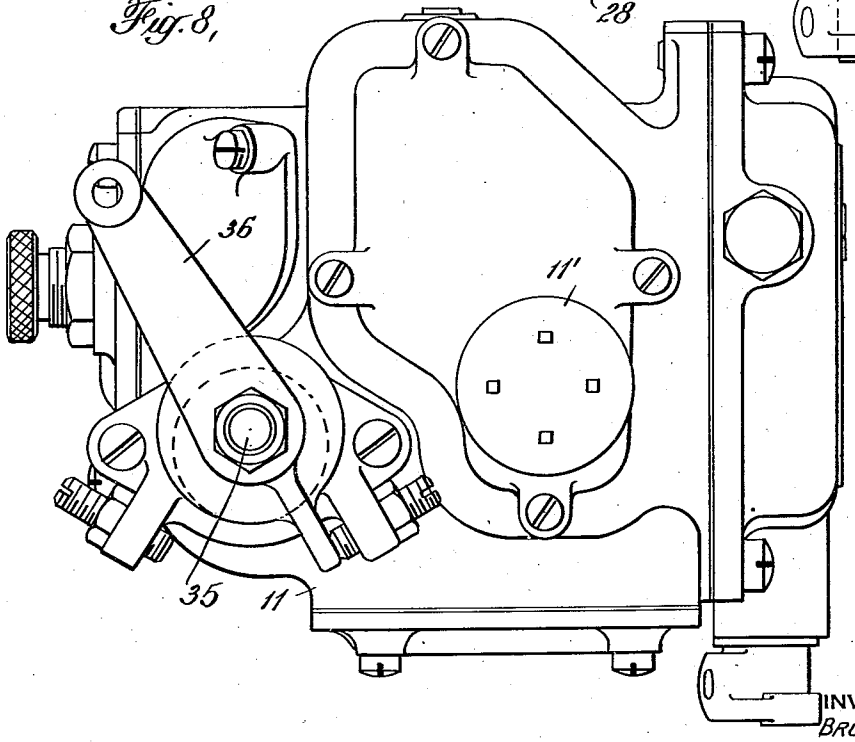


Fig. 8,



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Sept. 1, 1942. B. LOEFFLER 2,294,469

INJECTION PUMP GOVERNOR

Filed Nov. 1, 1939 7 Sheets-Sheet 7

Fig. 9,

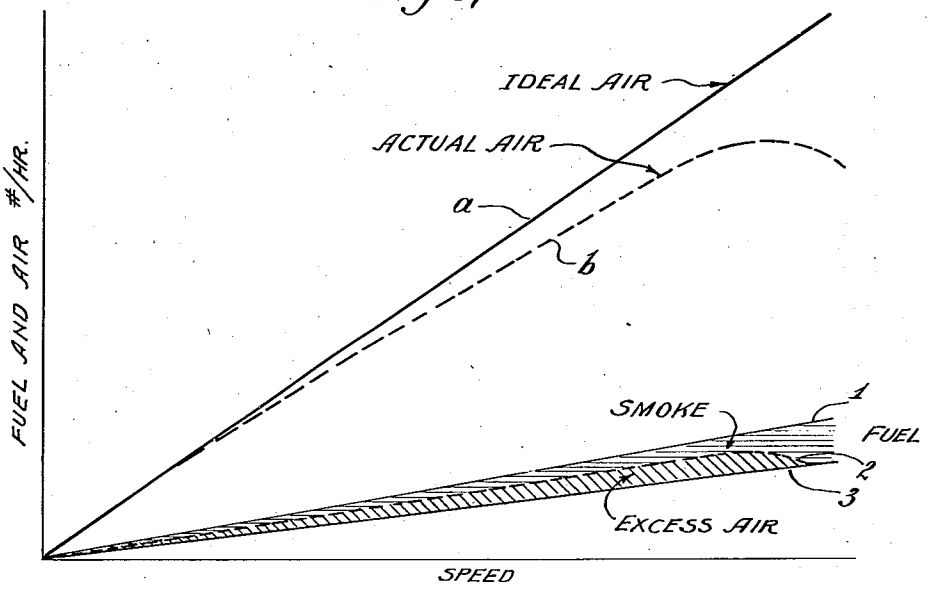
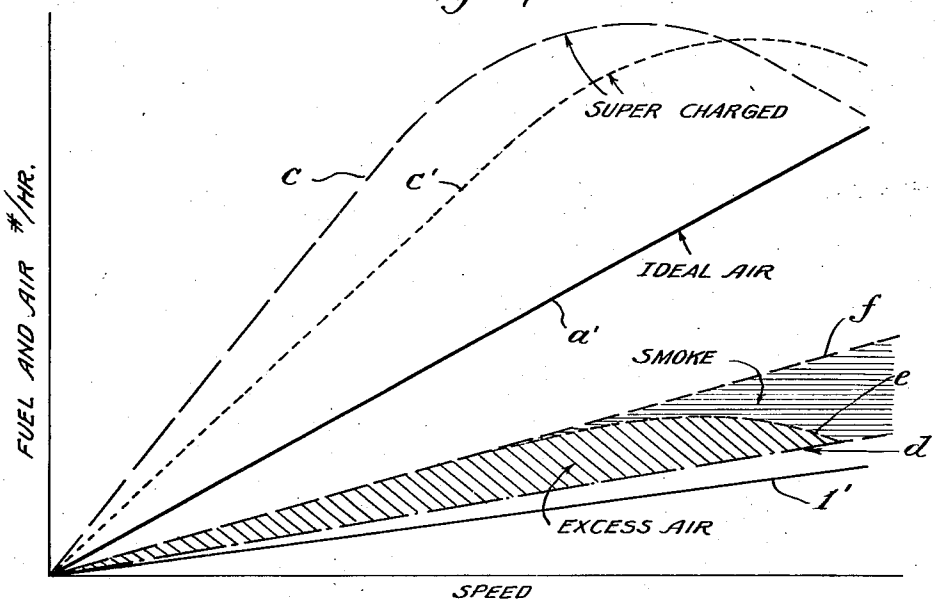


Fig. 10,



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Patented Sept. 1, 1942 2,294,469

UNITED STATES PATENT OFFICE

2,294,469

INJECTION PUMP GOVERNOR

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Application November 1, 1939, Serial No. 302,302

8 Claims. (Cl. 264—3)

The present invention relates to governor mechanisms and embodies, more specifically, an improved governor for fuel injection pumps such, for example, as used in connection with Diesel engines.

In Diesel engine operation it is commonly known that complete combustion is extremely difficult to obtain under all operating conditions. In fact, the attainment of proper air and fuel mixtures has always presented great difficulties in Diesel engine operation.

Whether the engine aspirates naturally or is supercharged, this difficulty is confronted. If the throttle setting is such as to afford the optimum air-fuel ratio at maximum engine speed, loss of power results at lower speeds because at such speeds there is an excess of air. If the fuel feed setting is higher, there will be an excess of fuel at high speed and smoking will result.

An object of the invention, accordingly, is to provide a mechanism by means of which the fuel feed is controlled in such fashion as to provide a correct ratio of air and fuel under all operating conditions.

A further object of the invention is to provide mechanism by means of which the supply of fuel to an engine may be controlled so that, at the maximum setting of the control at any given speed, too much fuel will not be delivered for proper combustion.

A further object of the invention is to provide a mechanism of the above character by means of which maximum use of the available air that is required by the power demand on the engine is accomplished. In other words, the invention proposes to insure optimum air-fuel ratio at all speeds.

A further object of the invention is to provide operating mechanism for an injection pump governor in which the mechanism is relieved of spring loads.

A further object of the invention is to provide a mechanism of the above character wherein the pump control rod is controlled for shut-off as well as maximum power conditions.

A further object of the invention is to provide a mechanism of the above character wherein one set of weights serves as a control for high speed, idling, and torque control.

Yet another object of the invention is to provide mechanism of the above character wherein separate springs are provided for high and low speeds, thus affording more exact response to the engine under all operating conditions.

Other objects of the invention will be apparent as it is described in greater detail in connection with the accompanying drawings, wherein:

Fig. 1 is a view in vertical section, taken on line 1—1 of Fig. 4, this view illustrating the drive and related control elements of one form of the invention.

Fig. 1—*a* is a detail view showing the control rod stop.

Fig. 2 is a view in section taken on line 2—2 of Fig. 1, being a view in transverse section and showing certain of the operating elements.

Fig. 3 is a view in section, taken on line 3—3 of Fig. 1 and showing the high speed spring and related operating parts.

Fig. 4 is a view in section taken on line 4—4 of Fig. 1 and showing the shut-off mechanism.

Fig. 5 is a view in vertical section taken on line 5—5 of Fig. 2.

Fig. 6 is a view in horizontal section taken on line 6—6 of Fig. 1 and looking in the direction of the arrows.

Fig. 7 is a view in horizontal section taken on the broken line 7—7 of Fig. 1 and looking in the direction of the arrows.

Fig. 8 is a plan view of the device.

Fig. 9 is a chart showing fuel and air curves for an engine aspirating normally.

Fig. 10 is a chart similar to Fig. 9 for a supercharged engine.

Before referring specifically to the mechanism shown in Figs. 1–8, the curves of Figs. 9 and 10 will be discussed. In Fig. 9, the air and fuel curves for a naturally aspirating engine are shown. Since the air is a function of the engine cylinder displacement, the ideal air curve is a straight line as shown at *a*. However, because of heating, wire drawing, etc., volumetric losses cause the curve to assume the form shown at *b*. At any given speed the ratio of the actual air to the ideal air is the volumetric efficiency.

The curve 1 in Fig. 9 represents the amount of fuel that could be completely burned in the ideal air, curves 1 and *a* representing the ideal conditions of a constant air-fuel ratio. For a given pump setting, fuel curves as a function of speed are essentially straight lines.

Since the actual amount of air will not support complete combustion of the amount of fuel represented by the curve 1, incomplete combustion and smoking results. The portion of the fuel not burned is represented by the shaded area between curves 1 and 2 in Fig. 9, curve 2 illustrating a constant air-fuel ratio for the actual air represented by curve *b*.

However, if a lower fuel setting is used as in-

dicated by curve 3 in Fig. 9, although at maximum engine speed the optimum air-fuel ratio is attained, for lower speeds there is an excess of air, and there thus results loss of power over that attainable with more favorable air-fuel ratios. The sectioned area between curves 2 and 3 represents this excess air condition and is a measure of the loss of power that might be delivered with a proper fuel curve.

In Fig. 10, the foregoing conditions are illustrated with a supercharged engine. The ideal air curve is shown at *a'* and the ideal fuel curve at *f'*. Curves *c* and *c'* indicate the air supply for two conditions of supercharging. The curve *d* illustrates the fuel rate for a setting that will give the desired air-fuel ratio at maximum speed. At lower speeds an excess air condition exists and the sectioned area between curve *d* and the curve *e* represents the loss due to failure to attain the full benefits of supercharging. The curve *e* shows the variable fuel rate for efficient use of the air under conditions of supercharging. Curve *f* illustrates the effect of using a greater pump discharge to take advantage of supercharging at lower speeds. The result is incomplete burning as illustrated between curves *e* and *f*.

Referring now to Figs 1–8, there is illustrated a torque control mechanism to proportion the fuel to the air supply so that the maximum setting of the control at any given speed will not permit the delivery of an excess of fuel, resulting in faulty burning. The mechanism insures the maximum use of the available air when such is required by the power demand.

The device is shown as being provided with a casing 11 in which a drive shaft 12 is journaled at 13 (Fig. 1). The drive shaft carries a gear 14 which is preferably driven by the shaft through a yielding connection 15 (Fig. 4) to prevent vibration from affecting the operation of the device. In order to prevent condensation within the casing, a breather is provided including a cover 11' and filter 11^2.

Gear 14 engages a pinion 16 on a shaft 17 journaled in the casing at 18. The shaft 17 carries centrifugal weights 19 which, when the speed of the shaft and driving mechanism increases, move outwardly to advance a sleeve 20 to the left as viewed in Fig. 1. Sleeve 20 is provided with a thrust collar 21 that engages a bifurcated arm 22 fixed to a shaft 23 (Fig. 2). The shaft 23 is provided with a ball step bearing 24 and needle bearings 25 and is further provided with a plurality of arms 26, 27 and 28 (Figs. 2, 5 and 7).

The arm 26 engages the idling speed spring 29 (Fig. 1) which is provided with an adjustable spring seat 30. The arm 26 is also provided with a pin 31 (Fig. 2) upon which a lever 32 is journaled. One end of the lever 32 is bifurcated at 33 to receive a crank pin 34 mounted eccentrically upon a throttle shaft 35 provided with an operating lever 36 controlled by the vehicle operator.

The other end of lever 32 is pivoted to an extension 37 of an injection pump control rod 38 (Fig. 1).

The arm 27 is provided with a head 39 (Fig. 3) adapted to engage a cap 40 mounted on a high speed spring 41, also provided with an adjustable seat 42. The cap 40 is held captive by a boss 43 formed in the casing so that arm 27 will not engage the high speed spring during low speed operation of the engine.

The arm 28 is pivoted to one end of a drag link 44 the other end of which is journaled at 45 to a pin 46 carried by a cam plates 47 (Fig. 7). The drag link is adjustable as illustrated at 48 and the cam plate 47 is pivoted at 49 to the casing.

The cam plate 47 is formed with a cam 50 (Fig. 7) that lies in the path of movement of a roller 51 journaled on the pump control rod 38. This mechanism is the maximum torque mechanism which will be referred to in greater detail hereinafter.

In order to shut off the engine fuel supply, the control rod 38 is provided with a pin 52, adapted to be engaged by an arm 53 carried by a manually operable shaft 54 and provided with a spring 55 normally urging the arm 53 away from the pin 52 (Fig. 1 and Fig. 4).

The control rod is provided with a stop as illustrated in Fig. 1—A. This mechanism is on the opposite side of the fuel injection pump from the governor mechanism shown in Figs. 1–8, and, in Fig. 1—A the control rod is again shown at 38. It is provided with a cap 56 that is adapted to seat against the fuel injection pump 57. The cap is provided with an adjustable plate 58 threaded therein and maintained in a desired position by a cotter pin 59. The plate 58 is engaged by the end of the control rod 38 to effect the desired fuel feed by the pump and this motion is transmitted to the pump by a sleeve 60. A collar 61 is threaded on the end of the control rod 38 and provides a desired degree of lost motion between itself and a cooperating shoulder 62 on the sleeve 60. This mechanism thus affords a control for the shut-off while the cam 50 provides a maximum fuel stop.

The operation of the governor may be described in connection with seven distinct operations as follows:

For fixed throttle position with the speed increasing, as, for example, by a falling off of the load with the fixed throttle setting, the weights 19 are moved further away from the shaft 17, thus moving the sleeve 20 toward the left and, through the yoke 22, moving the shaft 23 in a counter-clockwise direction as viewed in Fig. 7. This action compresses the idle spring 29, as well as the high speed spring 41 through the arms 26 and 27 respectively. Since the throttle is fixed, the eccentric pin 34 is stationary and counter-clockwise movement of the arm 26 carries the lever 32 to the left, the pivoting of the lever 32 being about the pin 34. This motion moves the control rod 38 to the left toward the stop position, causing the speed to be reduced until equilibrium is established between the load, speed and the fuel supply.

For fixed throttle with decreasing speed, as, for example, where there is an increase of load, the foregoing operations occur in a reverse direction to increase the fuel supply, provided the load is not an overload in which case the roller 51 engages the cam 50.

For constant speed with an increase of fuel feed, manipulation of the throttle lever 36 to increase the fuel feed to carry a greater load at the same speed causes the shaft 35 to be moved in a clockwise direction, as viewed in Fig. 8, moving the pin 34 to the left, as viewed in Fig. 7. The lever 32 now pivots at 31 on the arm 26 which, at this time, is fixed, causing a clockwise movement of the lever 32 to move the control rod 38 to the right to increase the fuel feed.

With a constant speed and decrease of fuel feed the motions are the same as those just described but in the reverse direction.

For idling of the engine, the arm 27 does not

engage the spring 41 and the forces of the governor weights are thus resisted only by the spring 29. Proper idling speed is obtained by adjustment of the spring seat 30. The speed is increased by turning the screw into the casing.

To shut off the engine, the shaft 54 is turned to rotate the arm 53 in a counter-clockwise direction in Fig. 1. This causes the arm 53 to strike the pin 52 and move the control rod 38 to the left, compressing the idle spring and shutting off the fuel supply to stop the engine.

For motoring or coasting, as for instance, when the wheels drive the engine, the throttle is closed. As the engine turns above idle speed, the action of the governor weights is to reduce the fuel supply still further, thus utilizing the full braking action of an engine in compression.

It will be observed that the component parts of the governor assume identical positions at the same speeds (excepting, of course, the throttle and pump control parts). The cam surface 50 should be so proportioned that for maximum power, the optimum air-fuel ratio obtains at all speeds. Moreover, the shape of the cam surface may also be used to limit the engine rating.

It will be observed that the mechanism affords one set of weights to control high speed, idling, and the torque control mechanism. Moreover, in this mechanism, the spring load is not carried through the operating lever.

A further feature of importance is the control of the travel of the injection pump control rod for shut-off as well as for maximum power.

In the governor drive mechanism, the yielding coupling prevents the transmission of shocks and vibration to the governor. The governor is independently lubricated and condensation is prevented by means of the breather, hereinabove described.

While the invention has been described with specific reference to the above drawings, it is not to be limited save as defined in the appended claims.

I claim:

1. A governor comprising speed responsive means, engine driven means to drive the speed responsive means, control means, link means actuated by the speed responsive means to operate the control means, a pivoted plate having a control surface, means on the control means adapted to engage the control surface, and means actuated by the speed responsive means to operate the pivoted plate to limit actuation of the control means by the speed responsive means.

2. A governor comprising speed responsive means, engine driven means to drive the speed responsive means, control means, link means actuated by the speed responsive means to operate the control means, a pivoted plate having a cam surface, a pin on the control means adapted to engage the cam surface, and means to actuate the plate by the speed responsive means to limit actuation of the control means by the speed responsive means.

3. A governor comprising speed responsive means, engine driven means to drive the speed responsive means, fuel supply control means actuatable at least in part by the speed responsive means, a torque control mechanism operable to yieldably resist movement of said speed responsive means toward high speed position, and means operatively associated with said control means and actuated by said speed responsive means to vary in accordance to the speed of the engine the maximum fuel supply position obtainable by said control means.

4. A governor comprising speed responsive means, engine driven means to drive the speed responsive means, fuel supply control means, link means actuated by the speed responsive means to operate the control means, a plurality of yielding means to resist movement of the control means by the speed responsive means when actuated in response to increase in engine speed, a manual throttle control mechanism, means to connect the manual mechanism to said link means to modify the action of the speed responsive means, and means having a surface movable by the speed responsive means to determine the maximum fuel feed position of the control means for different speeds of the engine.

5. An engine governor comprising speed responsive means, a manual throttle, a fuel control rod, a pair of elements pivoted together, one of said elements being connected at spaced points to said throttle and said control rod and the other of said elements being connected to said speed responsive means for movement thereby to modify the throttle control in accordance to engine speed, and means having a control surface movable relative to said control rod by said speed responsive means to vary the maximum fuel feed position obtainable by said control rod.

6. An engine governor comprising speed responsive means, a pivoted arm actuated by the speed responsive means, a spring engaged by the end of the arm to resist the operation of the speed responsive means, a pivot on the arm, a lever pivoted intermediate its ends on the pivot, a manual throttle control mechanism connected to one end of the lever, and a fuel control rod connected to the other end of the lever.

7. An engine governor comprising speed responsive means, a pivoted arm actuated by the speed responsive arm, a spring engaged by the end of the arm to resist the operation of the speed responsive means, a pivot on the arm, a lever pivoted intermediate its ends on the pivot, a manual throttle control mechanism connected to one end of the lever, a fuel control rod connected to the other end of the lever, a second arm actuated by the speed responsive mechanism, a second spring adapted to be engaged by the second arm, and means to provide for lost motion between the second arm and the second spring.

8. An engine governor comprising speed responsive means, a pivoted arm actuated by the speed responsive arm, a spring engaged by the end of the arm to resist the operation of the speed responsive means, a pivot on the arm, a lever pivoted intermediate its ends on the pivot, a manual throttle control mechanism connected to one end of the lever, a fuel control rod connected to the other end of the lever, a second arm actuated by the speed responsive mechanism, a second spring adapted to be engaged by the second arm, means to provide for lost motion between the second arm and the second spring, a third arm actuated by the speed responsive mechanism, and means operated by the third arm to limit the motion of the fuel control rod.

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