

July 14, 1953

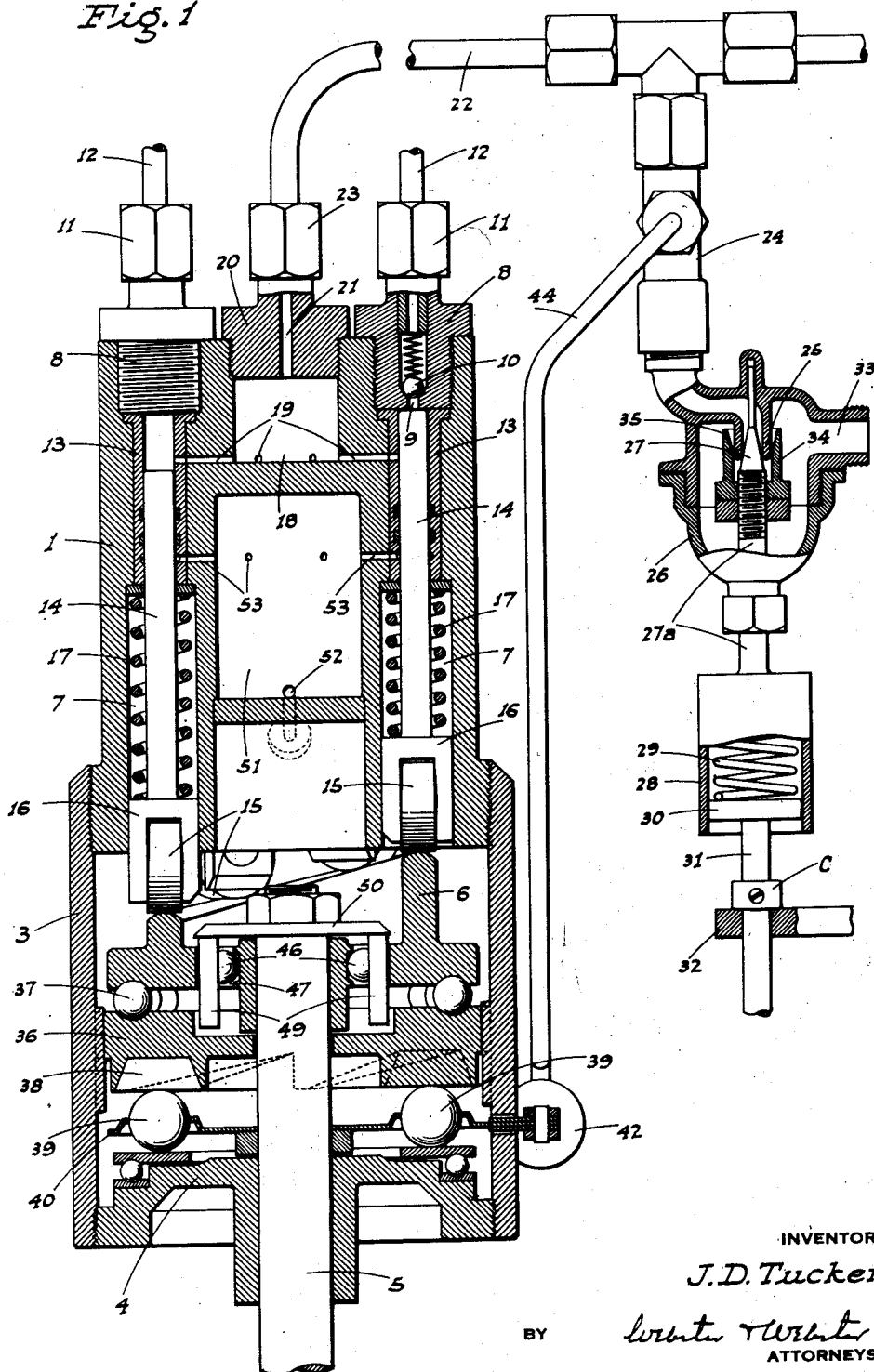
J. D. TUCKER
FUEL INJECTOR

2,645,182

Filed April 16, 1948

2 Sheets-Sheet 1

Fig. 1



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Fig. 2

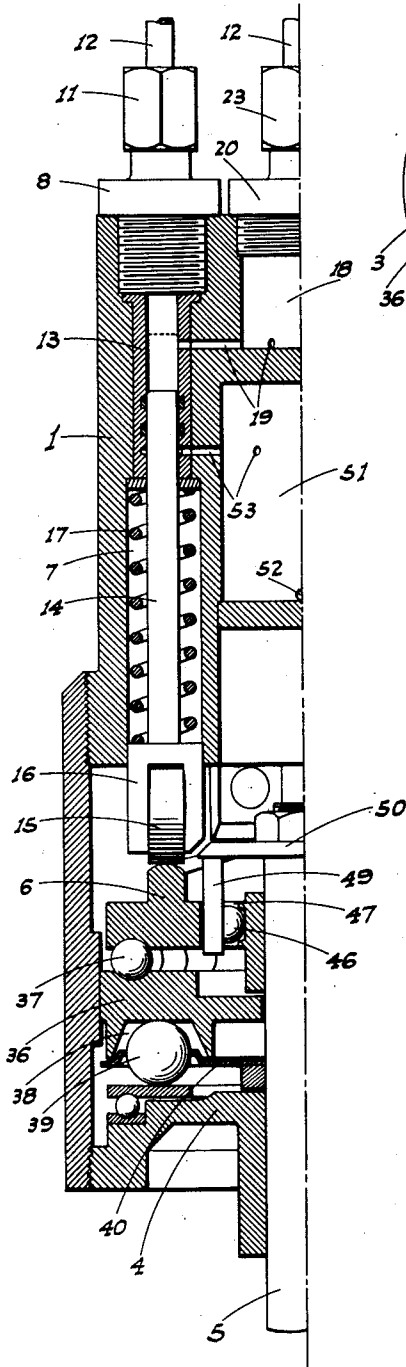


Fig. 4

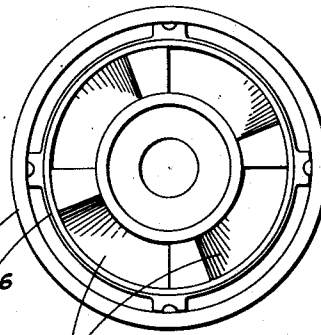


Fig. 3

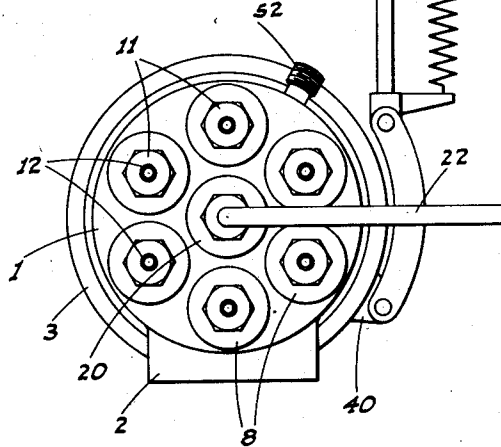
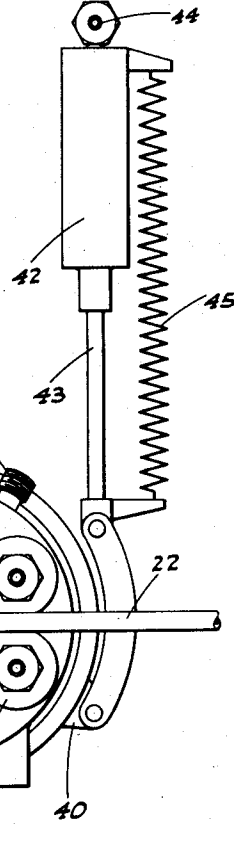
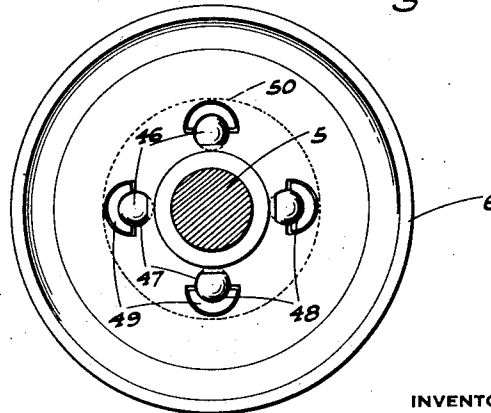


Fig. 5



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2,645,182

FUEL INJECTOR

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5 Claims. (Cl. 103—37)

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This invention is directed to, and it is an object to provide, an improved fuel injector for diesel engines.

Another object of the invention is to provide a fuel injector which includes a plurality of plunger-type fuel metering and distributing units in novel combination with a central fuel feed chamber which delivers to said units.

A further object of the invention is to provide a fuel injector, as in the preceding paragraph, which incorporates a receiving chamber and a bleed back arrangement for the recovery of the high pressure fuel which tends to work back along the plungers; such recovered fuel being returned to the supply tank.

An additional object of the invention is to provide a fuel injector which incorporates a novel mechanism for selectively controlling the pressure of the fuel as fed from the feed pump to the injector, whereby to regulate engine speed, and allow of efficient idling without stalling.

A further object is to provide means, operated automatically by fuel pressure change, to alter the effective stroke of the injector plungers so that the amount of fuel metered and fed to the engine with each stroke will be increased as the engine speeds up.

A further object of the invention is to provide a practical and reliable fuel injector and one which will be exceedingly effective for the purpose for which it is designed.

These objects are accomplished by means of such structure and relative arrangement of parts as will fully appear by a perusal of the following specification and claims.

In the drawings:

Fig. 1 is a sectional elevation of the improved fuel injector shown with the plungers in the position of greatest stroke efficiency.

Fig. 2 is a half sectional elevation of the injector with the plungers in the position of minimum stroke efficiency.

Fig. 3 is an end view of the main body of the fuel injector, taken from the outlet end.

Fig. 4 is an end view of the stroke-position adjusting cam disc.

Fig. 5 is an end view of the plunger actuating cam disc and showing its specific driving connection with the drive shaft.

Referring now more particularly to the characters of reference on the drawings, the improved injector comprises a main body 1 of generally cylindrical, elongated form; such body including, on one side thereof, a mount 2 for attachment of the device to a suitable support.

At one end the body 1 is fitted with a threaded-

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on cage 3, which includes an end bearing 4 in which a driven shaft 5 is journaled. The driven shaft 5 projects into the cage 3 and is there fitted with a rotary cam 6 having suitable thrust bearings associated therewith.

The main body 1 is formed with a plurality of circumferentially spaced, longitudinal bores 7 which extend parallel to the body axis and are initially open to both ends thereof.

Plugs 8 are threaded into the bores 7 at the end of the body opposite the rotary cam 6, each of said plugs including an axial passage 9 in which a check valve 10 is interposed; said check valve being spring-closed inwardly. The plugs 8 include fittings 11 by means of which the corresponding feed pipes 12 are connected to the injector; said feed pipes leading to corresponding ones of the engine jets (not shown).

Directly inwardly of the plugs 8 the bores 7 are each of somewhat reduced diameter for a certain distance, and this reduced-diameter portion of each bore is fitted with a cylinder forming sleeve 13, which includes internal rings, as shown.

Spring-retracted, cam-advanced plungers 14 work in the cylinder forming sleeves 13 from the rear ends of the same; said plungers having rollers 15 on their rear ends cooperating with the rotary cam 6; the rollers being carried in slidable guide heads 16. Helical compression springs 17 surround the plungers 14 between the sleeves 13 and guide heads 16, and said springs normally act to retract the plungers 14, maintaining the rollers 15 always in contact with the rotary cam 6.

Each cylinder-forming sleeve 13, together with the corresponding plunger 14, and the related working parts, form what may be termed a fuel metering and distributing unit.

The body 1 is formed, adjacent the sleeves 13, with a central fuel feed chamber 18, from which radial, fuel-delivery passages 19 lead into the cylinders formed by the sleeves 13, and in which cylinders the plungers 14 work.

Fuel under pressure is delivered into the chamber 18 as follows:

The forward part of the chamber 18 is defined by an end plug 20 screwed into the body centrally at its forward end; said plug including a passage 21, to which the fuel supply pipe 22 is connected by a fitting 23. Fuel under pressure feeds from pipe 22 through the fitting 23 and plug 20 into the chamber 18, and thence flows through passages 19 into the cylinder forming sleeves 13, when said cylinders are open by retraction of the corresponding plungers.

In retracted position of the plungers 14, the

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passages 19 are uncovered so that fuel, under pressure, may deliver into the cylinders formed by said sleeves 13. Of course this fuel entry into the cylinders, and operation of each plunger 14 for fuel injection, occurs successively by reason of the cam operation. In other words, each time a plunger 14 retracts, a charge of fuel enters the corresponding sleeve 13, and with advance of said plungers the corresponding passage 19 is closed off and the fuel is then forcefully delivered through the related check valve 10 into the communicating delivery pipe 12 leading to an engine jet.

The fuel supply pipe 22 is fed from a relatively high pressure fuel pump (not shown), and the following bypass and control valve mechanism is employed, to the end that the pressure of the fuel as delivered to the injector may be selectively regulated by the operator and an effective idling action of the engine automatically obtained when the latter is running free.

Such mechanism comprises a lateral 24 connected to pipe 22 and terminating in a cylindrical projection 25 within a body 26 and forming a valve seat for a needle valve 27 opening away from pipe 22. The needle valve, which is in effect a check valve, has a stem 27a slidably projecting from the body and connected to a barrel 28, serving as a retainer for a compression spring 29 which urges the stem to a valve closing position.

A piston 30 in the barrel 28 engages the end of the spring 29 opposite the stem 27a; said piston having an axial rod 31 projecting outwardly therefrom through a fixed member 32.

An adjustment collar C on the rod 31 bears against the member 32 to limit outward movement of the piston 30 under the influence of the compression spring 29.

The collar C serves as an initial adjustment whereby to regulate the minimum working pressure of the fuel in the supply pipe 22.

The rod 31 is shiftable toward the spring 29 by a hand or foot throttle so as to increase the loading of such spring, which in turn causes the valve 27 to maintain a higher pressure in the fuel supply pipe 22. This increase in pressure is for the purpose of increasing engine speed, as the greater the pressure of the fuel in chamber 18, a proportionately greater volume is injected by the device into the engine.

It will thus be seen that the load of spring 29 on stem 27a and valve 27 controls the extent of by-passing of fuel from lateral 24 (and pipe 22) through an outlet 33 from body 26, and thus regulates the fuel pressure in supply pipe 22 and in the fuel feed chamber 18.

Surrounding the cylindrical valve seat projection 25 is a cup 34 adjustably mounted on stem 27a within the body and below the needle valve; the bore of said cup from its base up having a slight clearance fit about projection 25 for a short distance when the needle valve is closed, and then flaring to its outer end as at 35. Cup 34 is thus a piston on the stem, the flat bottom of the cup providing a more effective fuel-contacting area for the pressure of the fuel to open the valve, than that provided by the needle valve itself.

Thus, when high pressure fuel opens the needle valve, such fuel, before it can escape through outlet 33, acts on the larger cup surface to lower the same. This in turn lowers the needle valve further, causing a relatively large flow of fuel to enter the cup and lower the same. This cup

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movement lowers the flare 35 so that a relatively large escape passage from the cup into the body (and to outlet 33) is thus provided. The pressure of the fuel in the line 22 is thus lowered almost immediately, which acts on the injector to reduce the amount of fuel fed thereby to the engine and provides for efficient idling of the same by reason of the mechanism hereafter described. Since the fuel pump which creates the pressure is driven by the engine, and such pump-generated pressure bears a direct relation to engine speed, it will be seen that a very sensitive control arrangement is provided.

In addition to the above described structure, I have provided a mechanism operated by changes in fuel pressure in pipe 22 as controlled by manipulation of rod 31, to alter the setting of the plungers 14 relative to intake passages 19 so that each plunger stroke, while of unchanging length, will have an increasingly effective pumping action with increase in pressure in pipe 22.

This mechanism in the main is interposed between the fixed bearing 4 and the cam disc 6, which is slidable but non-turnable on the shaft, and is constructed as follows:

Slidably fitted in cage 3 for axial movement back of disc 6 is another disc 36, there being thrust balls 37 between the discs.

The back or outer face of disc 36 is provided with arcuate cam grooves 38 arranged about a circle concentric with the shaft 5 and increasing evenly in depth from one end.

Balls 39 engage the different grooves 38 in the same relationship to each other, and ride on bearing 4. The balls are mounted in a keeper disc 40 turnable on the shaft 5 so that with rotation of said disc, the balls are moved about the shaft and are shifted along grooves 38.

It will thus be seen that if the disc 40 is rotated in one direction or the other through an arc not greater than the length of any groove 38, disc 36 and cam 6 will be advanced as balls 39 ride up the grooves 38, and will be retracted (by reason of the pressure of springs 17 thereon) as the balls 39 move down into the grooves.

As a result, the fully advanced position of plungers 14 may be shifted from a point adjacent plugs 8 and a correspondingly long distance beyond passages 19, as shown in Fig. 1, to one just a short distance beyond intake passages 19, as indicated in Fig. 2. With the former position of the plungers, a relatively great amount of fuel will be discharged into pipes 12 as compared with the amount of fuel fed into said pipes with the latter position of the plungers as will be evident.

The disc 40 is thus rotated, with changes of fuel pressure in pipe 22 by means of a hydraulic cylinder unit 42, the piston rod 43 of which is connected to disc 40 outside cage 3, as shown in Fig. 3. The feed pipe 44 to said cylinder is connected to pipe 22 so that pressure in said pipe will advance the piston rod in a direction to advance disc 36, while a spring 45 is applied to rod 43 to retract the same when the pressure in the cylinder is reduced and thus rotate disc 40 in the opposite direction or so as to cause retraction of disc 36 and cam disc 6. Thus, when the pressure in pipe 22 is high, as determined by pressure against valve 27, the plungers 14 act through a stroke of greater fuel-pumping efficiency, as when the engine is under load, than when the pressure in said pipe is low, as when the engine is idling.

To provide for ease of sliding of cam disc 6 along shaft 5, the two are operatively connect-

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ed by balls 46 caged and riding in holes 47 in said disc and engaged in longitudinal grooves 48 formed in pins 49 secured to and slidably projecting through disc 6 parallel to the shaft 5 from a plate 50 secured thereon.

In the described fuel injector, where the fuel is under very high pressure in the cylinders formed by the sleeves 13, some fuel may work back along said plungers 14. The following arrangement is provided for the recovery of such fuel, and to the end that it will not be lost:

Rearwardly of the central fuel feed chamber 18, the body 1 is formed with another and separate central chamber 51 which may be termed the fuel return chamber; there being a return passage 52 from the chamber 51 to the fuel tank (not shown).

Adjacent the forward end of the fuel return chamber 51, the body is formed with radial bleed-back passages 53 leading into communication with the cylinders formed by the sleeves 13. The position of the bleed-back passages 53 axially of the device is such that when the plungers 14 are in fully retracted position they do not uncover said passages. With reciprocation of the plungers 14 fuel which may tend to work back along the plungers gains access to the bleed-back passages 53 and flows into the feed return chamber 51, whence it is delivered by the return passage 52 to the fuel tank. With this arrangement an economy of fuel is accomplished.

The described fuel injector, while being relatively simple in its structure, is nevertheless quite rugged, and provides a practical and effective mechanism for the injection of high pressure diesel type fuels to engines.

From the foregoing description it will be readily seen that there has been produced such a device as substantially fulfills the objects of the invention, as set forth herein.

While this specification sets forth in detail the present and preferred construction of the device, still in practice such deviations from such detail may be resorted to as do not form a departure from the spirit of the invention, as defined by the appended claims.

Having thus described the invention, the following is claimed as new and useful, and upon which Letters Patent is desired:

1. A fuel injector comprising a body having a cylinder therein, the cylinder having a head, a fuel outlet passage from said head of the cylinder, a fuel inlet passage leading to the cylinder a distance from said head, a fuel pressure line leading to said inlet passage, a plunger slidable in the cylinder, means to reciprocate the plunger through a stroke of constant length from a point ahead of the inlet passageway to a point beyond the same, such latter means including a driven shaft, a rotary cam mounted in driving relation on the shaft and shiftable axially thereof, one end of the plunger riding said cam, and applied to the cam means to shift the cam axially along the shaft in one direction whereby to alter the range of reciprocation of the plunger relative to said inlet passage; said last named means comprising a non-rotatable disc movable axially on the shaft and on which the cam is rotatably

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mounted, the face of the disc opposite the cam being provided with an arcuate cam groove of increasing depth from one end and disposed in an arc concentric with the shaft, a fixed-level support for the disc turnable about the shaft, a disc-supporting element in the support ridable in the cam groove, and means to turn the support.

2. An injector as in claim 1 in which the last named means includes a hydraulic ram connected in operating relation to the support, and means to supply hydraulic pressure to the ram.

3. An injector as in claim 2 in which the means to supply fluid to the ram comprises a feed pipe leading from said pressure line to said hydraulic ram and effective to lead fluid under pressure from the conduit to the ram, and a spring acting on said support against the pressure in the ram.

4. A fuel injector comprising a cylinder having a head end, a fuel outlet passage from said head end, a fuel intake passage leading to the cylinder a certain distance from said head end thereof, a fuel pressure line leading to the inlet passage, a plunger slidable in the cylinder, means to reciprocate the plunger through a stroke of constant length from a point ahead of the intake passage to a point beyond the same and including a rotary member mounted for movement axially of the plunger and whose rotation reciprocates the plunger, another fuel pressure line connected to the first named pressure line, and means between the member and said other pressure line and actuated by pressure therein to move said member axially.

5. A fuel injector comprising a cylinder having a head end, a fuel outlet passage from said head end, a fuel intake passage leading to the cylinder a certain distance from said head end thereof, a fuel pressure line leading to the inlet passage, a plunger slidable in the cylinder, means to reciprocate the plunger through a stroke of constant length from a point ahead of the intake passage to a point beyond the same and including a rotary member mounted for movement axially of the plunger and whose rotation reciprocates the plunger, mechanism to move the member axially in one direction, and hydraulic pressure means to actuate the mechanism, and a fuel pressure line connected to the first named pressure line and to the last named means to actuate the latter.

JESSE D. TUCKER.

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