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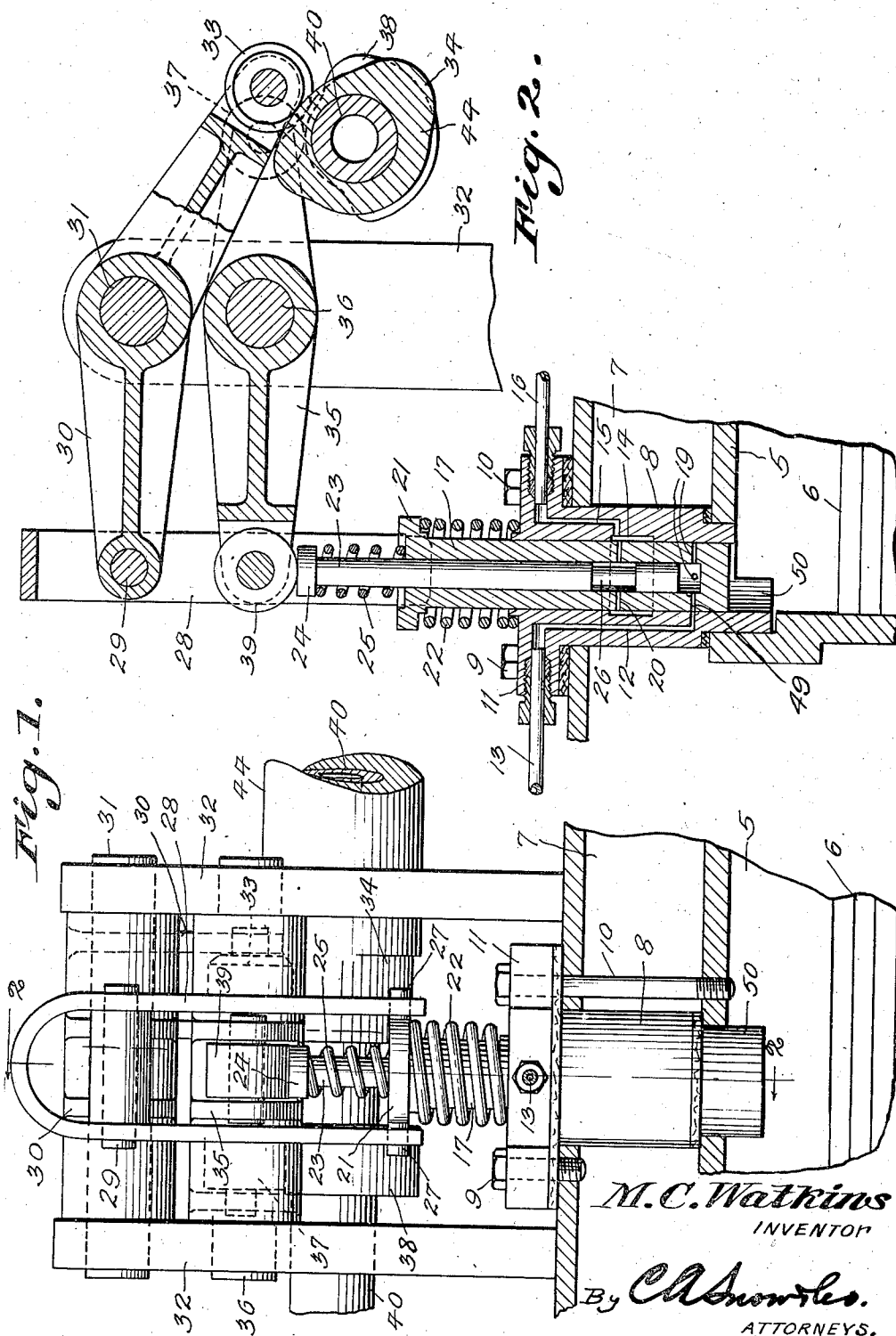
M. C. WATKINS

2,400,965

FUEL INJECTOR

Filed Aug. 3, 1942

2 Sheets-Sheet 1



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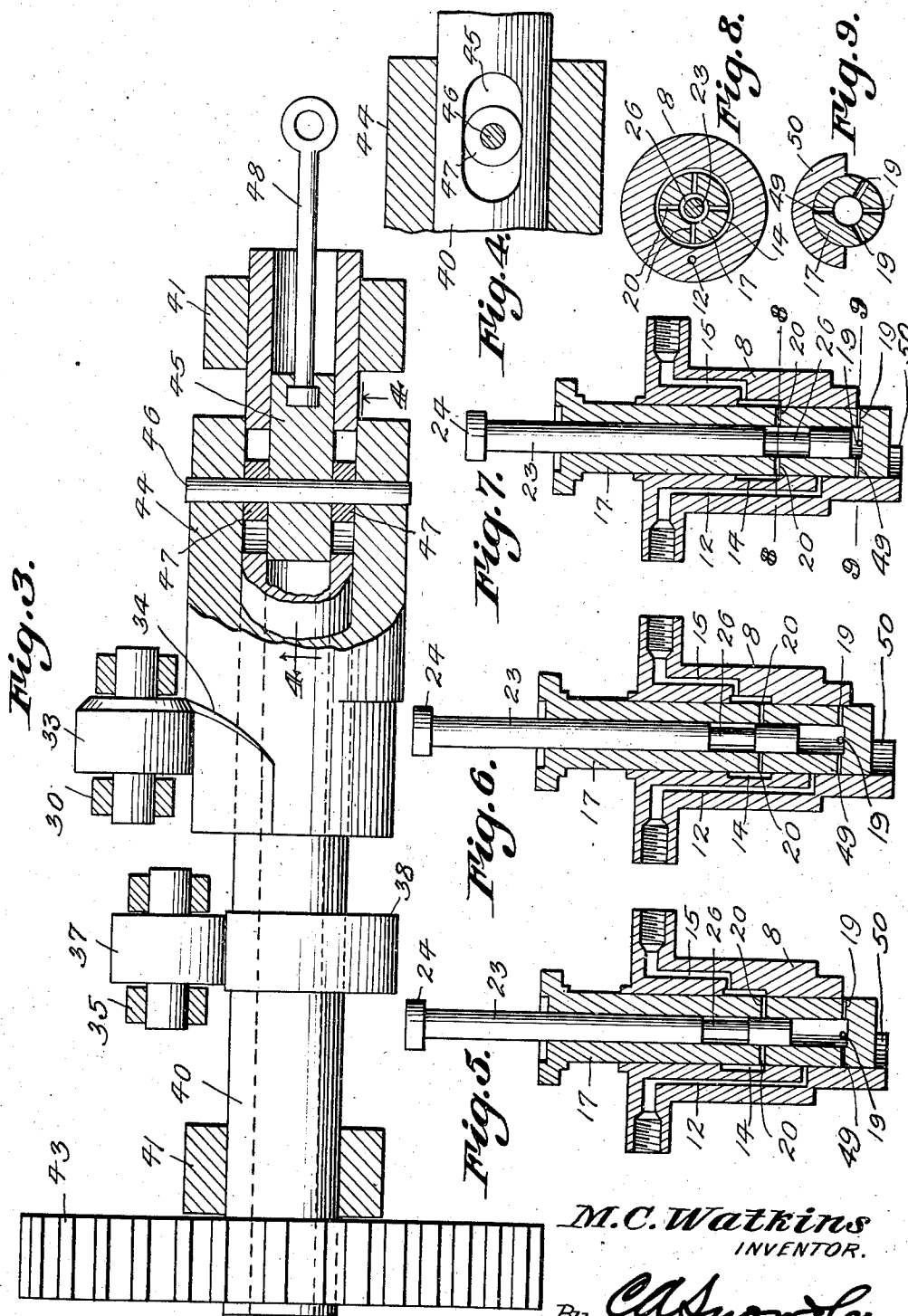
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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FUEL INJECTOR

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3 Claims. (Cl. 123-143)

This invention relates to fuel injectors for internal combustion engines, the object of the invention being to provide means whereby the usual low pressure engine may be converted into an engine possessing the advantageous operation characteristics and fuel economies of high compression motors, eliminating the massive construction of parts and the difficulties encountered in the manufacture and operation of high compression engines.

With the foregoing and other objects in view, which will appear as the description proceeds, the invention resides in the combination and arrangement of parts and in the details of construction hereinafter described and claimed, it being understood that changes in the precise embodiment of the invention herein described, may be made within the scope of what is claimed, without departing from the spirit of the invention.

Referring to the drawings:

Figure 1 is an elevational view of a fuel injector, constructed in accordance with the invention, illustrating the injector as positioned in a cylinder.

Figure 2 is a sectional view taken on line 2-2 of Figure 1.

Figure 3 is a plan view illustrating the cam and gear operating means.

Figure 4 is a sectional view taken on line 4-4 of Figure 3.

Figure 5 is a view illustrating the position of the injector piston during the compression stroke of the main piston of the engine.

Figure 6 is a sectional view illustrating the position of the cylinder or sleeve with respect to the mounting, when the main piston of the engine nears the limit of the compression stroke.

Figure 7 is a sectional view through the injector, illustrating the relative position of the injector piston and sleeve, with respect to the mounting, during the firing of the fuel charge.

Figure 8 is a sectional view taken on line 8-8 of Figure 7.

Figure 9 is a sectional view taken on line 9-9 of Figure 7.

Referring to the drawings in detail the reference character 5 designates an engine cylinder, in which the piston 6 operates. The reference character 7 designates the usual water jacket for the cylinder, through which the housing of the injector, indicated at 8, extends, to the end that the injector is maintained at the proper temperature to maintain the efficiency of operation.

The housing 8 is secured in position, by means

of the bolts 9 and 10 which pass through openings in the hood 11 of the injector housing, and extend into threaded openings of the cylinder, as clearly shown by Figure 1 of the drawings.

The housing 8 is formed with a bore 12 in which one end of the feed pipe 13 is positioned. The lower end of the bore 12 constituting the intake port communicates with the interior of the housing 8. The inner surface of the housing 8 is formed with an annular groove 14 which is disposed above the lower end of the bore 12, the annular groove 14 being substantially wide, for purposes to be hereinafter more fully described. The bore 15 at the opposite side of the housing 8 communicates with the annular groove 14, and provides a by-pass or drain passage through the pipe 16.

Mounted for vertical movement within the housing 8, is the sleeve or cylinder 17 which has its lower end closed. An inlet port indicated 49 is formed in the sleeve or cylinder 17, and this inlet port is adapted to register with the bore 12, during one cycle of operation of the engine, to permit a charge to enter the cylinder or sleeve 17, through the port 49. Transverse bores 19 extend through the wall of the sleeve or cylinder 17 and establish communication between the interior of the sleeve or cylinder 17 and engine cylinder with which the device is used, allowing the charge within the sleeve or cylinder 17 to pass into the engine cylinder, when the sleeve or cylinder 17 moves to the position shown by Figure 7 of the drawings, which is the firing position. Disposed above the bores 19, are bores 20 providing outlet passages which are adapted to establish communication between the interior of the sleeve or cylinder 17, and the annular groove 14.

Extending below the lower end of the housing 8 is a curved wall 50 which is adapted to close the inlet port 49 during one cycle of the engine, thereby preventing discharge through the inlet port 49.

Formed at the upper end of the sleeve or cylinder 17, is an annular flange 21 which provides a seat for the upper end of the coiled spring 22, the lower end of the spring 22 resting on the housing 8, the action of the spring 22 being to normally urge the sleeve or cylinder 17 upwardly.

Operating within the sleeve or cylinder 17, is a plunger or piston 23 that is of a length to extend an appreciable distance above the upper end of the cylinder or sleeve 17. A head indicated at 24 is formed on the upper end of the plunger or piston 23 and provides a stop against which the

coiled spring 25 rests, the opposite end of the coiled spring resting on the upper end of the cylinder or sleeve 17, normally urging the plunger or piston upwardly.

As clearly shown by Figure 2 of the drawings, the plunger or piston 23 is formed with an annular cutout portion 26 providing a passageway adapted to communicate with the passageways 20. Laterally extended bearings 27 are formed on the flange 21, the bearings 27 being disposed in bearing openings formed adjacent to the lower end of the yoke 28. Extending across the yoke 28, near the upper end thereof, is a shaft 29 to which the rocker arm 30 is connected, the rocker arm 30 being also mounted on the shaft 31 supported between the upright bearing arms 32. The rear end of the rocker arm 30, carries a roller 33 that moves over the cam 34 to be hereinafter more fully described. Operating adjacent to the rocker arm 30, is a rocker arm 35 which is also mounted between the upright bearing arms 32, on the shaft 36, and carries the roller 37 at its rear end, the roller 37 contacting with the cam 38.

On the forward end of the rocker arm 35, is a roller 39 that rests on the head 24 of the plunger or piston 23, so that movement of the rocker arm 35 may be transmitted to the plunger or piston 23, to accomplish the purpose of the invention.

The cam shaft on which the cams 34 and 38 are mounted, is indicated by the reference character 40 and operates in bearings 41 which support the cam shaft 40 on the engine, so that the spur gear 43 may receive motion from the main shaft of the engine, not shown. The cam 38 is secured directly to the cam shaft 40 and operates the rocker arm 35 to move the plunger or piston 23. The roller 33 on the inner end of the rocker arm 30, operates over the cam 34, which is formed on the inner end of the sleeve 44, the sleeve 44 being mounted for longitudinal movement on the cam shaft 40, as clearly shown by Figure 3 of the drawings. One end of the cam shaft 40 is hollow for the reception of the member 45, the member 45 being formed with a transverse bore, through which the shaft 46 extends, the shaft 46 also supporting the rollers 47, that move in elongated openings formed in the wall of the hollow end portion of the shaft 40. A throttle rod indicated at 48 connects with the member 45 and is adapted to move the member 45, so that the sleeve 44 may be moved toward and away from the roller or inner end of the rocker arm 35 to the end that the action of the cam 34 may be varied by increasing or diminishing the length of the cam surface contacting with the roller 33 on the end of the rocker arm 30.

Figure 2 illustrates the relative position of the sleeve or cylinder 17 and piston 23, at the beginning of the compression stroke of the piston 6. In this position, the force of the spring 25 between the head 24 of the piston and top of the cylinder 17, tends to move the piston 23 upwardly, producing a vacuum in the chamber between the lower end of the piston 23 and bottom of the cylinder 17 and since the ports 49 and 19 are in registry, fuel is drawn into said chamber.

The length of time that these inlet ports remain open, and consequently the amount of fuel drawn into the chamber, is governed by the position axially, of the cam 34, on the shaft 40, which is controlled by the position of the throttle rod 48.

The contours of the cams 34 and 38 are such that as the piston rises on the compression stroke, the cylinder 17 and piston 23, move to

the position shown by Figure 5 of the drawings. In this position, as air pressure is built up by the rising piston 6 in its cylinder, a quantity of air mixes with the fuel already in the chamber at the lower end of the cylinder 17. As the piston 6 nears the top of the compression stroke, the members 17 and 23 move to the positions shown by Figure 6 of the drawings. At this step of the cycle of operation, ports 49 and 19 are closed by the wall of the housing 8. The pressure of the fuel and air in the chamber, is approximately the same as the air pressure in the cylinder 5. As the piston 6 reaches the top of the compression stroke, cam 38 operates to force the piston 23 downwardly, closing the chamber at the bottom of the cylinder 17. At this point the cylinder 17 is prevented from moving upwardly, by the action of the cam 34, and is prevented from moving downwardly by the spring 22, combined with the air pressure in the cylinder acting against the closed bottom of the cylinder 17.

As the piston 23 descends, the pressure in the chamber at the lower end of the cylinder 17, is effective only on the relatively small space at the bottom of the chamber at the lower end of the cylinder 17, in forcing the cylinder 17 downwardly, with the result that the difference in the size of the effective areas on which the pressures act in opposition to each other, causes the pressure in the chamber to be relatively higher than the pressure in the cylinder 5. The engine is so designed that this pressure in the chamber at the bottom of the cylinder 17, is higher than the ignition pressure of the fuel used, which causes the fuel to ignite and burn with the air in the chamber. When this combustion takes place, the pressure in the chamber at the lower end of the cylinder 17 rises, forcing cylinder 17 downward against the pressure in the cylinder 5, to the position shown in Figure 7 of the drawings. When the cylinder 17 and piston 23 reach the positions shown in Figure 7, the burning fuel and air pass from the chamber, through port 19, into the cylinder 5 where they unite with the oxygen in the cylinder and complete combustion takes place, forcing piston 6 downward on the firing stroke of the engine. Piston 23 continues downward, completely closing the chamber, the piston 23 and cylinder 17 remaining in this position, during the exhaust and intake strokes of the engine.

It will of course be understood that the cylinder 5 of the engine, is provided with intake and exhaust valves not shown, that control the passage of air to the engine cylinder, as well as the passage of products of combustion from the cylinder, in the usual and well known manner.

What is claimed is:

1. In a device of the class described, a plug including a cylindrical housing adapted to be positioned in an opening of an engine cylinder, said housing having a fuel inlet port disposed adjacent to the lower end thereof, a vertically movable sleeve having its lower end closed, operating within the housing, said sleeve having an inlet port adapted to register with the fuel inlet port of the housing, through which fuel passes into the vertically movable sleeve, said sleeve having a plurality of outlet openings, a plunger operating within the sleeve and adapted to compress a fuel charge within the sleeve at a relatively higher degree of pressure than the cracking pressure of the fuel used with the engine, igniting the fuel charge within the sleeve, and means for moving the vertically movable sleeve

releasing the fired charge through the outlet opening of the sleeve, to the engine cylinder, firing a charge within the cylinder.

2. In a device of the class described, a plug including a cylindrical housing adapted to be positioned in an opening of an engine cylinder, said housing having a fuel inlet port, a vertically movable sleeve having its lower end closed, operating within the housing, said sleeve having an inlet opening and a plurality of normally closed outlet openings, said inlet opening adapted to register with the fuel inlet port of the housing, admitting a charge to the sleeve, a plunger operating within the sleeve and adapted to compress a charge in the sleeve at a higher degree of pressure than the cracking pressure of the fuel used, igniting the charge within the sleeve, means for operating the sleeve and plunger, said operating means including rocker arms adjustable with respect to each other, whereby the degree of pressure of the fuel charge within the housing is regulated according to the grade of fuel used, and the closed end of the sleeve adapted to move to a position below the lower end of the housing, releasing a fired charge into the engine cylinder, firing a charge therein.

leasing a fired charge into the engine cylinder, firing a charge therein.

3. In a device of the class described, a plug including a cylindrical housing adapted to be positioned in an opening of an engine cylinder, said housing having a fuel inlet port, a semicircular wall extended beyond the lower end of the housing, a vertically movable sleeve having its lower end closed, mounted within the cylindrical housing, said sleeve having an inlet opening adapted to register with the inlet port of the cylindrical housing, admitting a fuel charge to the sleeve, said sleeve having outlet openings, a plunger operating within the sleeve and adapted to compress a charge within the sleeve at a higher degree of pressure than the cracking pressure of the fuel used, igniting the charge within the sleeve, means for operating the sleeve and plunger, whereby a charge fired in the sleeve passes through said outlet ports of the sleeve into the engine cylinder, firing a charge therein, the inlet opening of the sleeve being closed by said semicircular wall, during the firing of the charge.

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