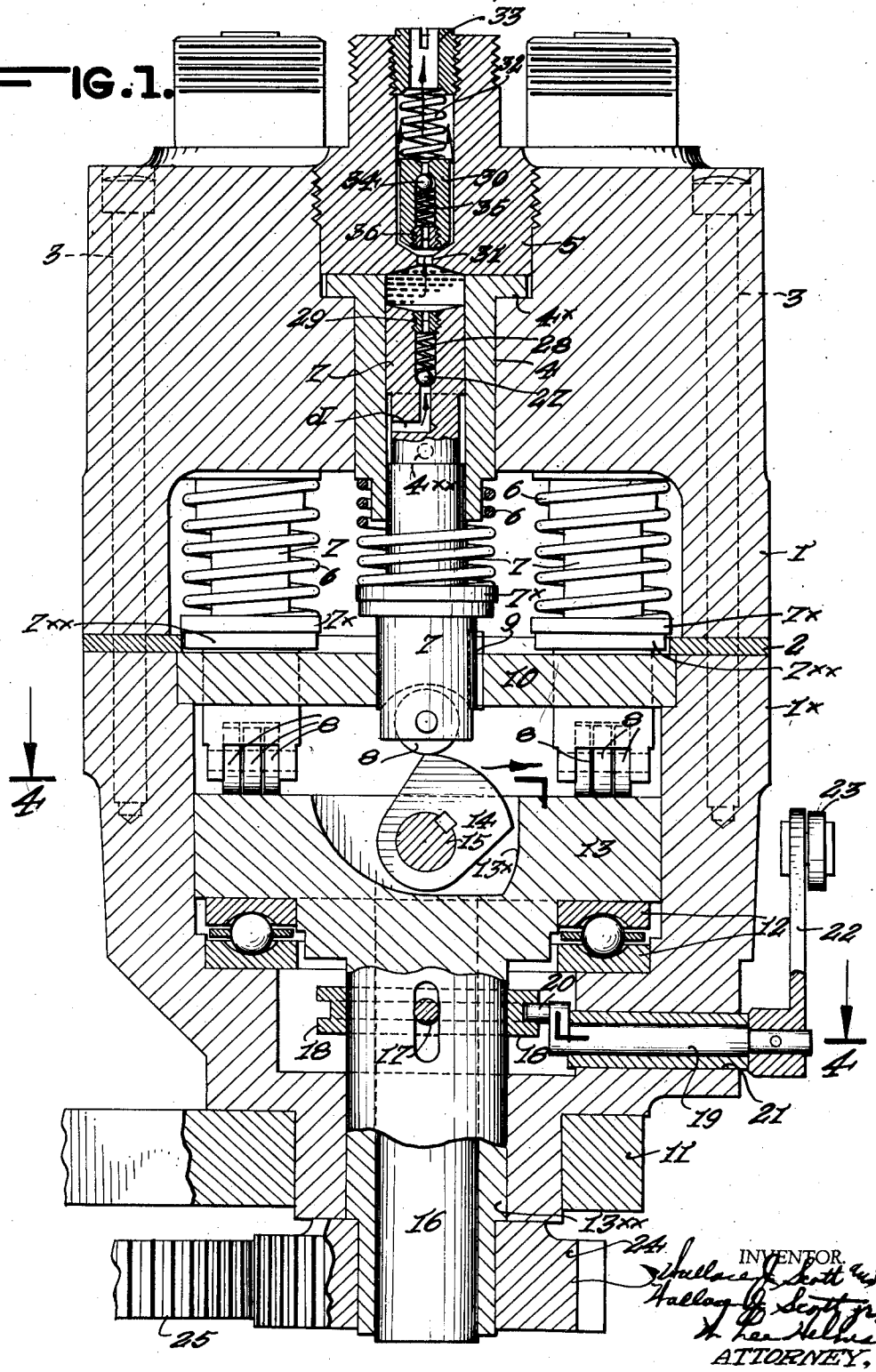
March 21, 1944. W. J. SCOTT ET AL 2,344,565

FUEL INJECTOR FOR DIESEL ENGINES AND THE LIKE

Filed June 30, 1941 4 Sheets-Sheet 1

FIG. 1.



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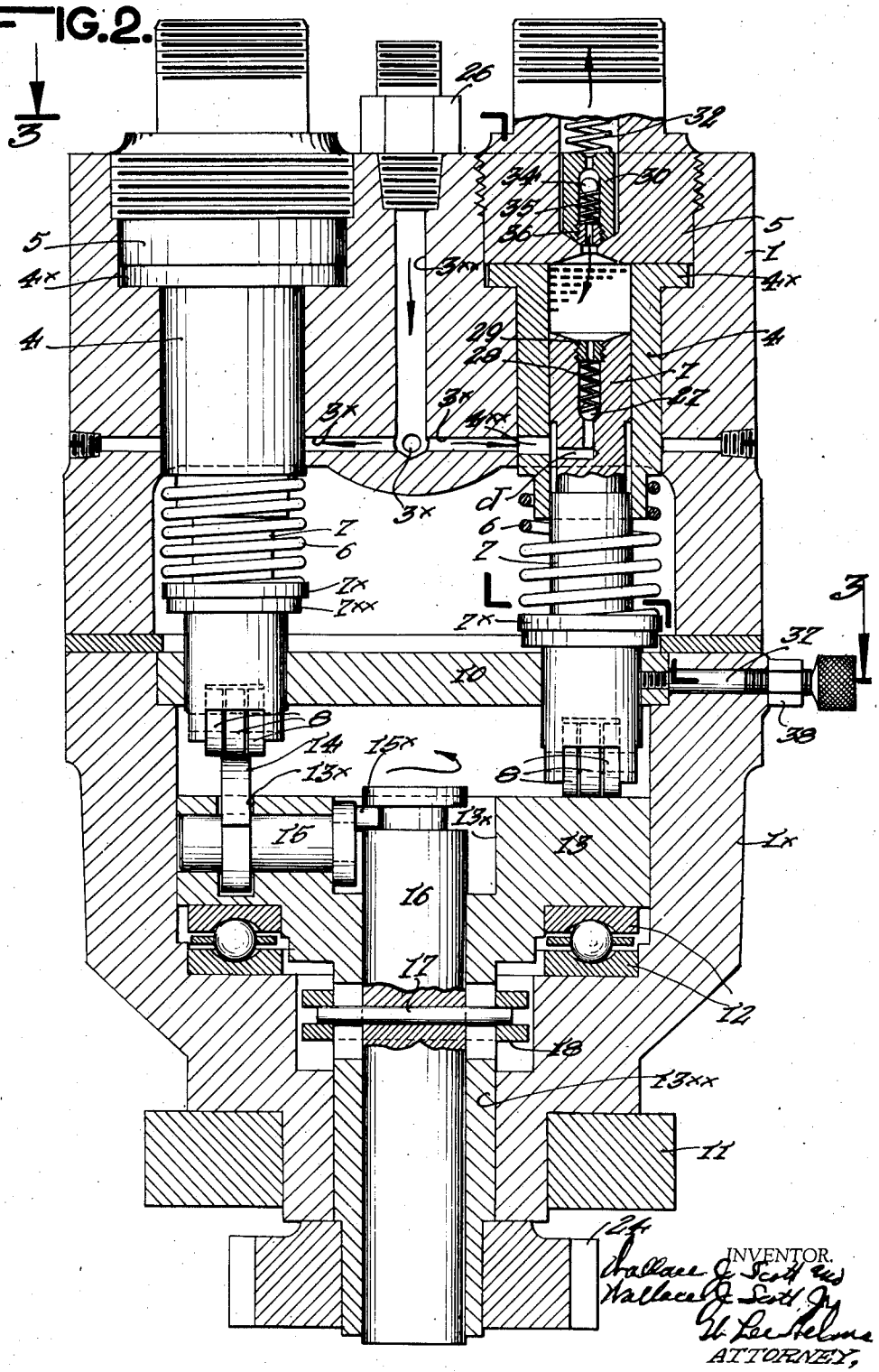
FUEL INJECTOR FOR DIESEL ENGINES AND THE LIKE

Filed June 30, 1941 4 Sheets-Sheet 2

FIG. 2.



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FUEL INJECTOR FOR DIESEL ENGINES AND THE LIKE

Filed June 30, 1941 4 Sheets-Sheet 3

FIG. 3.

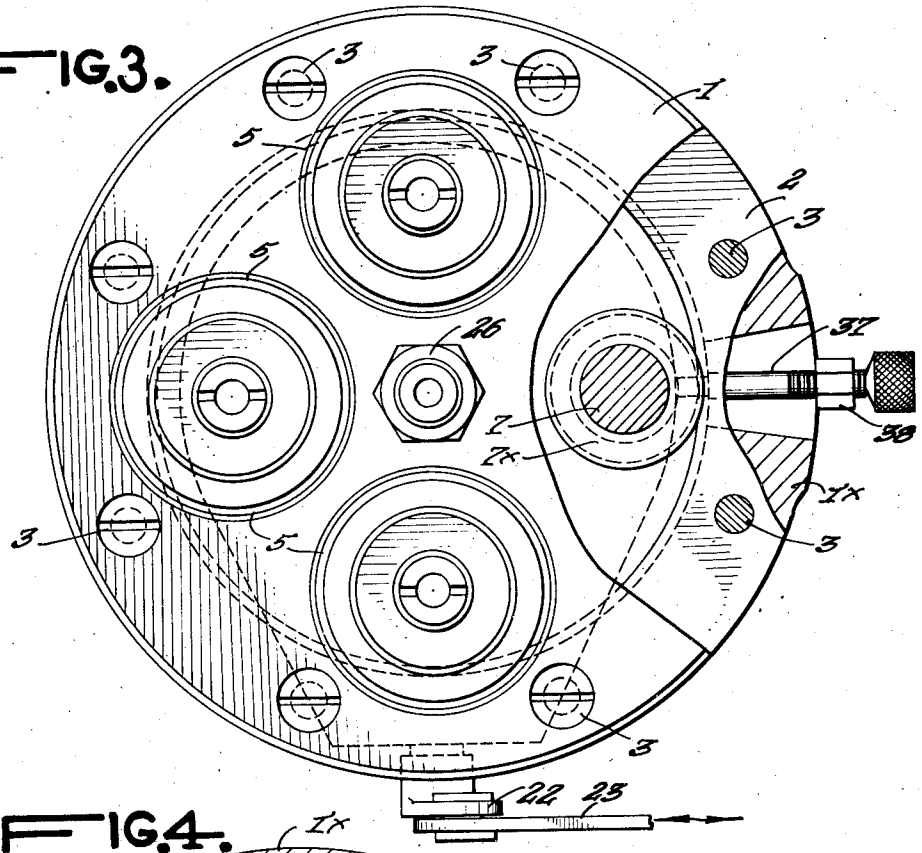
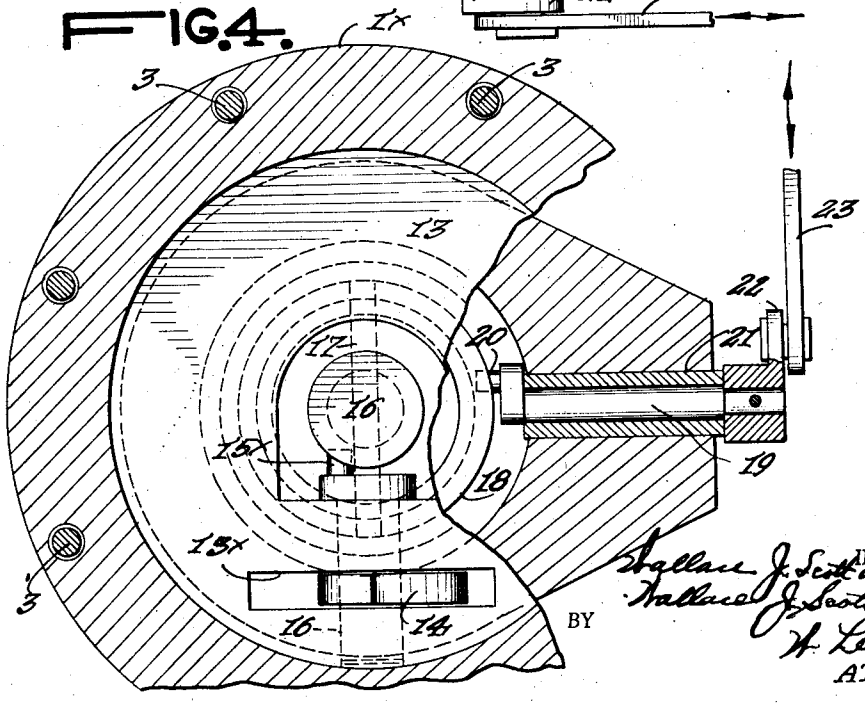


FIG. 4.



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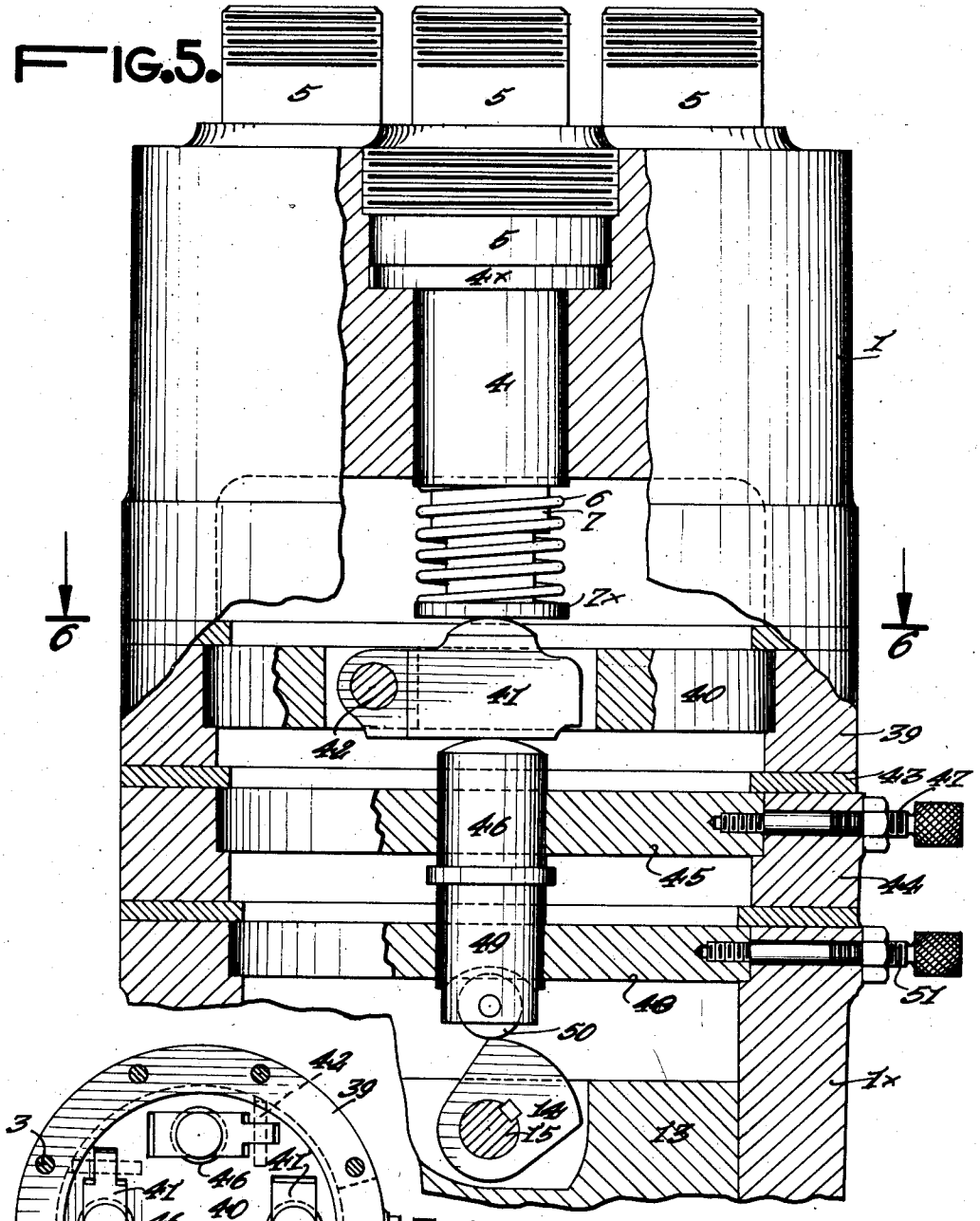
FUEL INJECTOR FOR DIESEL ENGINES AND THE LIKE

Filed June 30, 1941 4 Sheets-Sheet 4

FIG. 5.



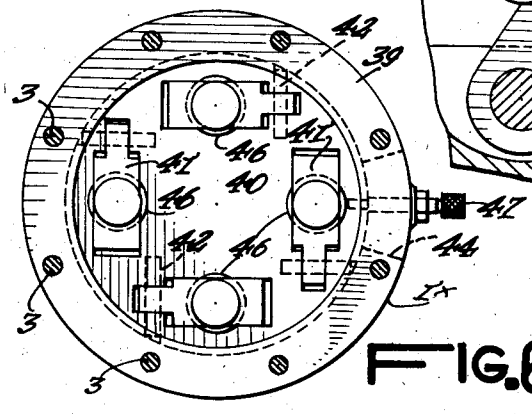


FIG. 6.

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UNITED STATES PATENT OFFICE

2,344,565

FUEL INJECTOR FOR DIESEL ENGINES AND THE LIKE

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Application June 30, 1941, Serial No. 400,536

4 Claims. (Cl. 103—41)

The object of the present invention is to provide a Diesel fuel injector of great simplicity and ease of adjustment, the characteristic being that only one lifting cam is necessary for operation of the injector for either single cylinder or multiple cylinder engines, and the construction provides an ease of control for all conditions, which is not found in existing types of apparatus for the purpose.

The invention will be described with reference to the accompanying drawings, in which:

Figure 1 is a sectional elevation illustrating an embodiment of the invention, the section being parallel with the face of the single actuating cam for the several injector plungers.

Figure 2 is a sectional elevation of the said embodiment extended at substantially right angles to the view shown in Figure 1.

Figure 3 is a top plan view broken away on the line 3—3, Figure 2.

Figure 4 is a horizontal section on the line 4—4, Figure 1.

Figure 5 is a sectional elevation broken away at its base showing modified forms of the device.

Figure 6 is a view in horizontal section on the line 6—6, Figure 5.

Referring to the drawings and Figures 1 and 3, it will be seen that the embodiment illustrated is adapted for a four cylinder engine or one having a lesser number of cylinders. A cylindrical housing employing two sections 1 and 1*x*, is employed, a packing ring 2 being interposed between the sections and the sections being held in rigid connection by bolts or screws 3. The upper section is provided with a plurality of annularly arranged bores, of a number corresponding with the number of cylinders in the engine for which the injector is designed. Each of these annularly arranged bores is preferably formed with a lower area of lesser diameter and an upper area of greater diameter, as shown more particularly in Figures 1 and 2. Referring to the latter figures, it will be seen that in the bore of lesser diameter is inserted an injector cylinder sleeve 4 having a top flange 4*x* which rests upon the lower face or base of the bore area having larger diameter. Threaded in the larger bore is a closure plug 5 which serves as a valve housing. Each sleeve preferably extends downwardly into a chamber of housing section 1 and is formed with a shoulder and receiving area for a spiral spring 6, the shoulder being provided by reducing the lower end of said sleeve 4. The lower end of the spring bears against an intermediate shouldered area 7*x* of an injection plunger 7, the latter preferably carrying at its lower end a plurality of rollers 8. In the present embodiment these rollers are three in number.

The injector plunger 7, in each case, is preferably formed with a longitudinal keyway which may extend upwardly into the shouldered area 7*x*. The key 9 may be carried by the injector plunger so as to slide in the channel formed in a disk-plate 10 carried by the lower housing section 1*x* or the key may be fixed to said plate.

In the present embodiment the lower housing section 1*x* is formed with a depending neck which may fit within an aperture formed in a bracket or other suitable support for the device such as that indicated at 11, Figure 1.

Within housing section 1 and mounted upon the bearing ring 12 is a rotary cam carrier 13 which is formed with a vertical channel at 13*x* to receive and permit axial movement of injector cam 14, the latter being keyed to a shaft 15 which is mounted in a bearing aperture formed in rotary cam carrier 13. The inner end of shaft 15 carries an eccentrically disposed crank pin 15*x* which enters a horizontal channelway at the top of a vertically movable rod 16 mounted within the sleeve-like depending portion 13*xx* of the rotary cam carrier.

A pin 17 is so carried by rod 16 that the ends of the pin enter apertures in a channel ring 18. Referring to Figure 1 it will be seen that channel ring 18 receives a crank stud 20 carried eccentrically of the shaft 19 which may be oscillated in a bearing sleeve 21 fitted within an aperture formed in housing section 1*x*, the outer and projected end of shaft 19 receiving a lever arm 22 which may be connected by means of a link 23 with a hand or foot control, the operation of which will impart endwise movement to rod 16 and thereby change the position of cam 14 to increase or reduce its degree of lift relatively to the injection plungers 7.

In the embodiment shown there is secured to the lower projected end of sleeve-like extension 13*xx* of the rotary cam carrier a gear 24 which may be driven by a gear 25 operated from the Diesel engine to which the injector will be applied. When, however, the injector is applied to a two-cycle engine the rotary cam carrier may be directly driven from the crank shaft to the engine.

Now, referring again to the injector plungers 7, it will be seen that each plunger is reduced in diameter for a short distance intermediate its length to receive oil from a passageway or port

at 4xx in injector cylinder 4 which port is in register with a duct 3x in housing section 3 and which is in communication with the main oil feed bore 3xx of said housing section, the latter having threaded therein a nipple 26 for connection with an oil line under pressure.

At its reduced oil-receiving section each injector plunger 7 is formed with an oil duct d leading upwardly to a ball check chamber of larger diameter and in which is disposed the ball check 27 engaged by a spring 28 at the top of which is a threaded holding plug 29 apertured for passage of oil.

The closure plug 5 is axially bored in each case, to receive a discharge and line relief valve 30 which normally closes a port at 31 leading to and from the injector cylinder, valve 30 being engaged at its top by spring 32 below a threaded nipple 33 leading, in each case, to one of the cylinders of the Diesel engine by means of a pipe connection (not shown).

Within the axial bore of valve 30 is a ball check 34 engaged by a spiral spring 35 held in position by a small inverted plug 36. In the operation of the embodiment illustrated in Figures 1 to 4 inclusive, rotation of shaft 16 and the rotary cam carrier 13 in which it is mounted will carry cam 14 into successive engagement with the injection plungers which are spaced equally in circular arrangement, and, at the same time, the channel ring 18 which is secured to the shaft or vertically movable rod 16 will in its rotation remain in operative relationship with stud 20 with the cam adjusting means, so that the operative throw of the cam may be adjusted at will during the operation of the injector.

As each injector plunger is driven upwardly in an active stroke, the ball check 27 will be closed by the pressure imposed upon the oil immediately above the plunger. This pressure will raise valve 30 (which may be longitudinally fluted) and the fuel oil charge will be forced around valve 30 and upwardly through the conduit leading to the appropriate combustion cylinder of the Diesel engine. When the cam leaves the plunger the latter will descend and valve 30 will drop into closed position.

When valve 30 is dropped into closed position and pressure in the injector cylinder is relieved by the downward movement of the plunger, the high pressure in the line above said valve is immediately relieved, said pressure causing ball check 34 to open the internal passageway of the valve for such purpose. Any oil in the line above valve 30 in excess of that needed for line pressure relief will not be sucked back into the oil injection chamber of the injector cylinder, because immediately upon relief of excess pressure in the line and the balancing of the pressures above and below valve 30, check 34 will be moved to closed position by spring 35.

Cam 14 with its quick-acting adjusting means acts as a throttle to control the speed of the engine. Thus link 23 may be connected to a foot pedal or hand lever, as will be understood without further explanation.

The disk 18, resting on an annular shoulder provided by the lower casing section 1x may be given a rotary adjustment by means of the lever rod 37, upon loosening nut 38 threaded on the rod, inasmuch as the rod passes through an elongated slot in the housing 1x as indicated at 44, Figure 6, and thus timing can be controlled. The amount of lifting motion given by the cam 14 depends on how much of the cam projects above the top surface of the cam-retaining disk 13 and adjustment in the height of the cam is effected by rotating shaft 15, on which the cam is mounted, this rotation being effected by engagement of the walls of the channel in shaft 16 with stud 15x carried eccentrically of shaft 15 at the inner end thereof. Shaft 16 is encircled by peripherally channeled collar 18 into the channel of which projects stud 20 eccentrically mounted on shaft 19 carrying lever 22 which, in turn, is connected to pull rod or link 23. The adjustments of the disk 18 and cam carrier 13 may be effected during the rotation of the cam carrier. Collar 18 is held against rotation on shaft 16 by a pin 17 passing through the latter and through elongated slots formed at opposite points in the sleeve-like hub depending from cam retaining disk 13.

In the modified embodiment illustrated in Figure 5, all of the elements from and including the rotary cam carrier and the cam carried thereby, including adjusting means for the cam to the drive gear 24, are the same as in the preceding embodiment and like reference characters are employed. Also all of the elements of the first embodiment which are carried by the upper housing 1 are employed for the modification illustrated in Figure 5 and like reference characters are employed. There has been added by the modification a characteristic made possible by the addition of a few extra elements. With the use of these added elements the injector is capable of universal use, inasmuch as it can be used for a wide range of engine cylinder displacements.

Referring to Figure 5, it will be seen that immediately below housing 1 there has been interposed a housing ring 39 carrying a heavy plate 40 having apertures receiving a plurality of rocker arms 41, one for each injector plunger, the rocker arms being pivoted on pivot pins 42. Immediately below housing ring 39, except for a packing ring 43, is a second housing ring 44 carrying an axially adjustable disk 45 in which are mounted a plurality of actuator rods 46, one for each rocker arm. As indicated in Figure 6, housing ring 44 is formed with a wide slot through which passes a lever rod 47 secured to disk 45, by means of which the actuator rods may be adjusted simultaneously toward and from the axis of movement of the appropriate rocker arm in each case.

Rotatably carried by housing 1x at its top is a disk 48 carrying a plurality of actuator rods 49, each lying under and in contact with an appropriate one of the actuator rods 46. Each actuator rod 49 carries at its lower end three rollers 50, the center one of which directly receives the stroke of cam 14 in the revolutions of the rotary cam carrier 13, and those at each side straddling the cam slot in the cam carrier.

By the adjustment of disk 45 the rocker arm actuator rods 46 will effect fuel control, less fuel being injected as to each cylinder of the engine when disk 45 is adjusted to carry actuator rods 46 away from the pivot points of the rocker arms, adjustment of the said disk 45 in a reverse direction producing a reverse effect. As in the case of disk 18 of the first embodiment, disk 48 of the modification carries an adjusting lever rod which, in Figure 6, is indicated at 51 and which passes through a wide slot near the top of housing section 1x so that disk 48 may be rotated in a direction to advance the timing of injection with respect to each cylinder, or, rotated in the opposite direction to retard the timing injection.

By means of the modification, an adjustment is provided which gives the equivalent of plac-

ing small or larger injector cylinders and plungers in a fuel injector of standard type.

By mounting the cam 14 at the periphery of the rotary cam carrier the injector cylinders and push rods may be arranged regularly instead of parallel as in the embodiments illustrated. This arrangement will be useful when the injector is applied to radial engines, particularly high-speed radial engines customarily employed in aircraft. When so arranged, the injector would add very little to the depth of the radial engine and could be mounted coaxially therewith so as to be driven directly from the engine crank shaft whenever the engine is of two-cycle form. Also the high pressure oil outlet of each injector cylinder would be immediately adjacent the cylinder of the engine to which it is appropriate and the high pressure fuel lines would be short and all equally distant with respect to the cylinders of the engine.

It will be understood that various modifications may be made in the form and arrangement of the elements comprising the embodiments above illustrated, in addition to those just above described. As an example, means may be provided for rotating the rocker arm carrier 40 to relatively adjust the positions of the plungers and rocker arms for increased or decreased movement of the plungers to supplement or eliminate the adjustment provided for carrier 45.

Having described our invention, what we claim and desire to secure by Letters Patent, is as follows:

1. In injectors for Diesel engines, a plurality of injector cylinders arranged in an annular path, means for leading fuel oil to the injector cylinders, an actuating cam, a rotary carrier for said actuating cam, means for rotating the carrier to bring the cam into successive engagement with the plungers, a shaft for the cam and rotatably carried by the cam carrier, and means for rotating said shaft during the rotation of the cam carrier, said means comprising a second shaft mounted in and coaxially of the cam carrier, means intermediate the second shaft and the cam shaft whereby endwise movement of the second shaft will rotate the cam, and means operable during rotation of the cam carrier for imparting endwise movement to the second shaft.

2. An injector for Diesel engines constructed in accordance with claim 1, in which the cam carrier is formed with a sleeve coaxially receiving the second and endwise movable shaft, a channel ring connected to said latter shaft and a crank lever operatively connected to the channel ring for imparting endwise movement to the said second shaft.

3. In injectors for Diesel engines, a plurality of injector cylinders arranged in an annular path, means for leading fuel oil to the cylinders, a plurality of sectional plungers, the sections of each plunger being relatively movable into and out of coaxial relationship, a rotary carrier for an actuating cam, an actuating cam on said carrier, means for simultaneously moving one section of each of the plungers into or out of coaxial arrangement with the second section, and means for rotating the carrier to bring the cam into successive engagement with the plungers.

4. In injectors for Diesel engines constructed in accordance with claim 3, in which one section of each plunger is mounted within one of the injector cylinders and the second section of each plunger is disposed exteriorly of an appropriate injector cylinder, the means for relatively moving the sections of the plungers comprising a member receiving said second plunger sections and supporting them for endwise movement.

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