This invention relates to fuel oil injection apparatus for internal combustion engines of the Diesel type, and its object, generally, is the improvement of devices of this character.

Another object of my invention is to provide apparatus which may be adjusted to govern the time and quantity of fuel feed according to the duty of the engine and to regulate its speed.

Other objects and advantages of the invention will appear from the following description.

The invention is illustrated in the accompanying drawings, in which,—

Figure 1 is a side sectional elevation of an internal combustion engine with an embodiment of my invention applied thereto. Fig. 2 is a detail longitudinal sectional view of the fuel oil injector and a portion of the engine cylinder. Fig. 3 is a side elevation, partly in section, of the oil feed pump and the mechanism for operating and regulating the action of the same. Fig. 4 is a view partly in side elevation and partly in section of the pressure accumulator which controls the feed inlet valve.

In said drawings, the reference numeral 5 represents the cylinder of a vertical engine provided with a reciprocating piston 6 and having the usual air intake and exhaust valves which may be operated as by means of levers and rods, such as 7 and 8, from a cam shaft 9.

According to the present invention I provide, preferably in the cylinder head 10, a tubular guide or casing 11 having as shown in Fig. 2, a bore 12 and a counter bore 13.

Supported upon an annular shoulder at the bottom of the bore 12 is a nozzle 14 having one or more discharge openings, such as 15, which are closed by means of a valve 16, pressed, and the valve 16 is yieldingly held upon a seat provided therefor in the nozzle 14, by means of a helical spring 23 acting between stop rings 24 and 25 engaging respectively against said bushing and a peripheral ledge 26 provided on the valve stem.

By having the spring thus connected it is apparent that the effective power of the same in maintaining the valve in its closed position may be regulated by suitably adjusting the bushing 20.

Said valve stem is provided with an oil duct 27 extending from its upper end to branch outlets 28 adjacent to the valve and communicating with the chamber of a hollow bellows member 29, hereinafter designated as the fluid pressure accumulator. This fluid pressure accumulator is connected by non-leakable or ground joints at its upper and lower ends respectively with the valve stem and the nozzle and has a contact bearing against each. As best shown in Fig. 4, the fluid pressure accumulator 29 is of a substantially cylindrical shape formed with alternating circumferential ridges 30 and grooves 31, said ridges being provided interiorly with recesses 32. The accumulator 29 is resilient and normally contracted, and by its peculiar nature and shape, it is expansible axially to effect the instantaneous unseating of the valve 16 when the accumulator is subjected to an internal pressure sufficient to expand the same and overcome the power of the spring 23.

Oil is supplied to the accumulator through the duct 27 in the stem 17, which latter is connected by a feed pipe 33 with an oil pump 34. Said pump is of the type known as force pump having a plunger 35, see Fig. 3, whose suction strokes in the illustrated embodiment are produced by a retracile spring 36 and the oil ejecting strokes by means of a lever 37 which is actuated through the instrumentality of a cam 38 on the engine cam shaft 9. 39 represents a roller provided on said lever to reduce the friction between the lever and cam.

As illustrated, the cam is provided with a periphery including a relatively long surface 40 concentric with the shift axis and a recess 41 into which the roller 39 retreats in the successive rotations of the cam.

The quantity of oil delivered from the pump through the feed pipe 33 is, moreover, dependent upon the extent of movement of lever 37 which movement is, in turn, gov-
erned by the distance, radially of the cam, which the roller 39 is permitted to enter the recess 41.

To vary the oil feed I provide the lever 5 with a projection 42 which is engageable by an adjustable stop which is, preferably, in the nature of a set screw 45 extending through a controlling arm 44 which is adjustably mounted on the pivot support 45 for the lever 37. A regulating screw 46 extending through a threaded hole in the arm 44 and against a post 47 serves to position the stop 43 with respect to the lever projection 42.

48 represents a spring acting in opposition to the regulating screw 46 to enable the lever to be controlled thereby.

The arm 44 is also provided with a socket 49 for a handle, indicated by broken lines 50, for operating the lever manually to actuate the pump as, for example, to prime the engine preparatory to running the same.

The invention operates as follows: The fuel oil is forced by the pump plunger 23 through the feed pipe 33 and the duct 27 of the valve stem 17 into the accumulator 29 to ultimately communicate a sufficiently high pressure within the latter to effect the longitudinal expansion of the accumulator 30 in opposition to the spring 23, thereby unseating the valve 16 to enable a charge of oil to be instantaneously delivered at a high pressure from the accumulator in the form of a spray into the cylinder 5. The pressure under which the oil is discharged must be greater than the contractile power of the accumulator and the effective power of the spring 23 tending to maintain the valve upon its seat.

Immediately after such an ejection of oil, the oil pressure within the accumulator is reduced, whereupon the resiliency of the accumulator acts to contract the same to permit the closing movement of the valve 16.

Such closing movement of the valve is facilitated by the action of the spring 23.

By suitably adjusting the valve closing spring 23, or the lever stop screw 43 and the regulating screw 46, the accumulator is accordingly influenced to effect the delivery of a charge of fuel oil into the engine cylinder responsive to one or more delivery strokes selectively of the pump plunger whereby the fuel charges may be varied as to quantity and occurrence.

By thus adjusting the spring 23 and the plunger-stroke regulating means the plunger strokes are rendered effective to fulfill several important functions, that is to say—

with relatively short plunger strokes more than one delivery stroke is essential to produce the requisite pressure in the accumulator to deliver a charge to the engine cylinder; a longer plunger stroke will supply normal charges to the engine cylinder at or near the termination of every delivery stroke of the plunger; while still longer plunger strokes may be employed to deliver an abnormally large fuel charge to the engine cylinder during each delivery stroke of the plunger by reason of the influence of the plunger being extended considerably beyond the initial delivery of the respective charge.

The construction of the illustrated embodiment of the invention now preferred by me and its operation will be apparent from the foregoing description.

It is to be understood, however, that I do not desire to be confined to the specific construction shown and described, for modifications in the details may be made within the scope of the following claims.

What I claim is—

1. In a fuel feeding device for internal combustion engines of the Diesel type, an apertured nozzle, a spring-seated valve controlling the apertures of the nozzle and having a slidably mounted stem formed with an enlargement, and a resiliently normally contracted axially expansile fluid pressure accumulator in the form of a bellows surrounding the valve, said fluid pressure accumulator being interposed between and bearing at its ends respectively against the nozzle and the enlargement of the valve stem to have non-leaky joints with the same, said valve stem having a fuel duct adapted for connection with a source of supply of fuel under pressure and opening within said fluid pressure accumulator, the arrangement being such that a predetermined high pressure of fuel in said fluid pressure accumulator will axially expand the latter to instantaneously move the valve and open the apertures of the nozzle.

2. In a fuel feeding device for internal combustion engines of the Diesel type, a tubular casing adapted to be secured to the engine, an apertured nozzle independent of and located in one end of said casing, a valve controlling the apertures of the nozzle and having a stem slidably guided in the casing, a resiliently normally contracted and axially expansile fluid pressure accumulator in the form of a bellows surrounding the valve within said casing, said fluid pressure accumulator being engaged at one end with said nozzle and operatively connected at its other end to said valve stem, said valve stem having a fuel duct adapted for connection with a source of supply of fuel under pressure and opening within said fluid pressure accumulator, and a spring acting to normally seat the valve for closing the apertures of the nozzle, the arrangement being such that a predetermined high pressure of fuel in said fluid pressure accumulator will axially expand the latter to instantaneously move the valve and open the apertures of the nozzle.
3. In a fuel feeding device for internal combustion engines of the Diesel type, a tubular guide, an apertured nozzle seated in one end of said guide, a valve controlling the apertures of the nozzle and having a stem slidably mounted in said guide and formed with an enlargement between its ends, a resilient normally contracted axially expansible fluid pressure accumulator in the form of a bellows surrounding the valve, said fluid pressure accumulator having non-leakable joints at its ends respectively with the nozzle and the valve stem, the accumulator and the valve seating-spring having such contractile power that a predetermined high pressure is required in the accumulator to cause the same to axially expand to instantaneously move the valve and open the apertures of the nozzle, and means to facilitate supply of fuel under pressure into the accumulator and the nozzle.

4. In a fuel feeding device for internal combustion engines of the Diesel type, an apertured nozzle, a spring seated valve controlling the apertures of the nozzle and having a slidably mounted stem, a resilient normally contracted and axially expansible fluid pressure accumulator in the form of a bellows surrounding the valve, said fluid pressure accumulator having non-leakable joints at its ends respectively with the nozzle and the valve stem, the accumulator and the valve seating-spring having such contractile power that a predetermined high pressure is required in the accumulator to cause the same to axially expand to instantaneously move the valve and open the apertures of the nozzle, and means to facilitate supply of fuel under pressure into the accumulator and the nozzle.

Signed at Seattle, Washington, this 26th day of August, 1921.

ERIC JOHNSON.