Jan. 2, 1923.

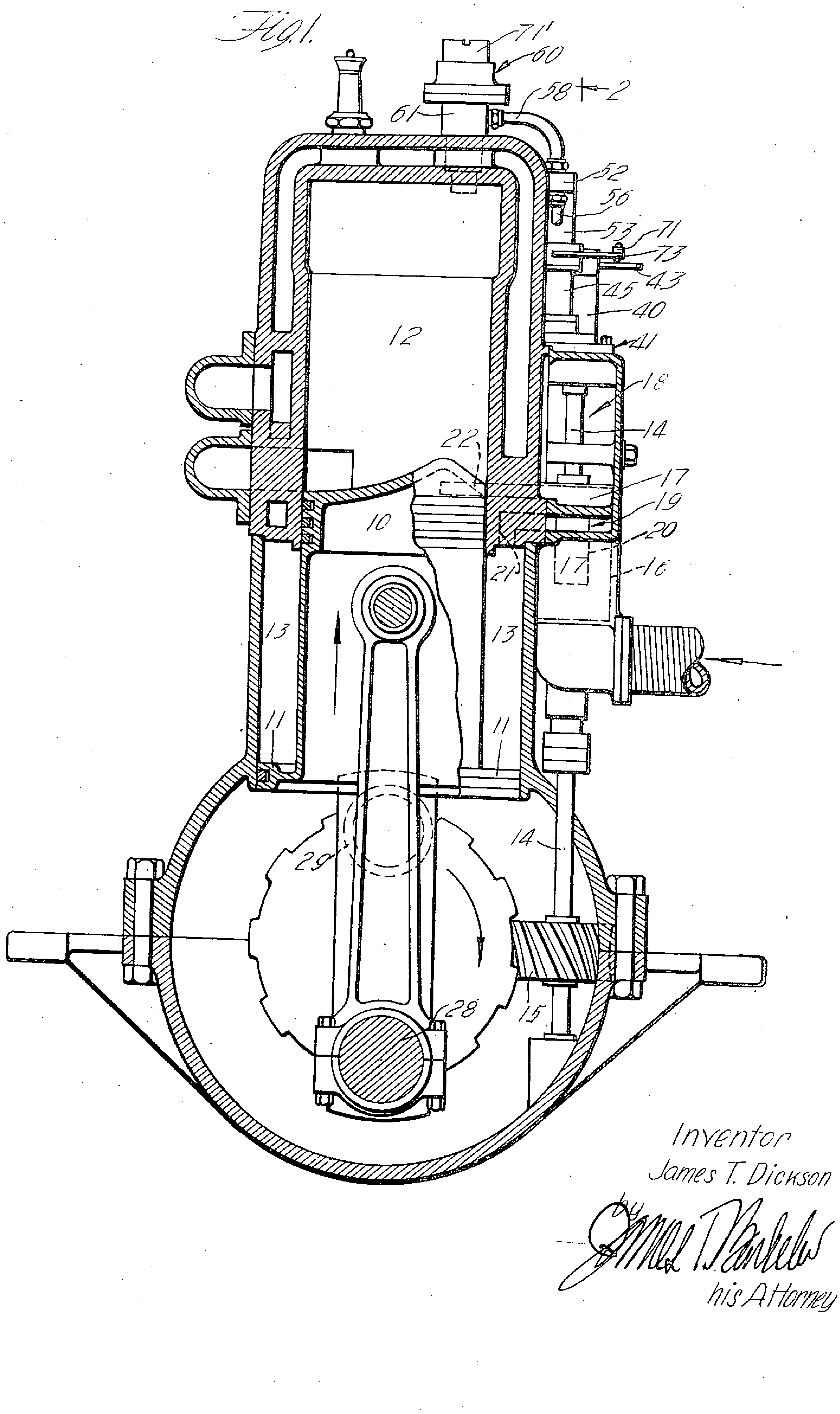
J. T. DICKSON.

1,440,913.

INJECTION MECHANISM FOR INTERNAL COMBUSTION ENGINES.

FILED FEB. 4, 1919.

3 SHEETS—SHEET 1.



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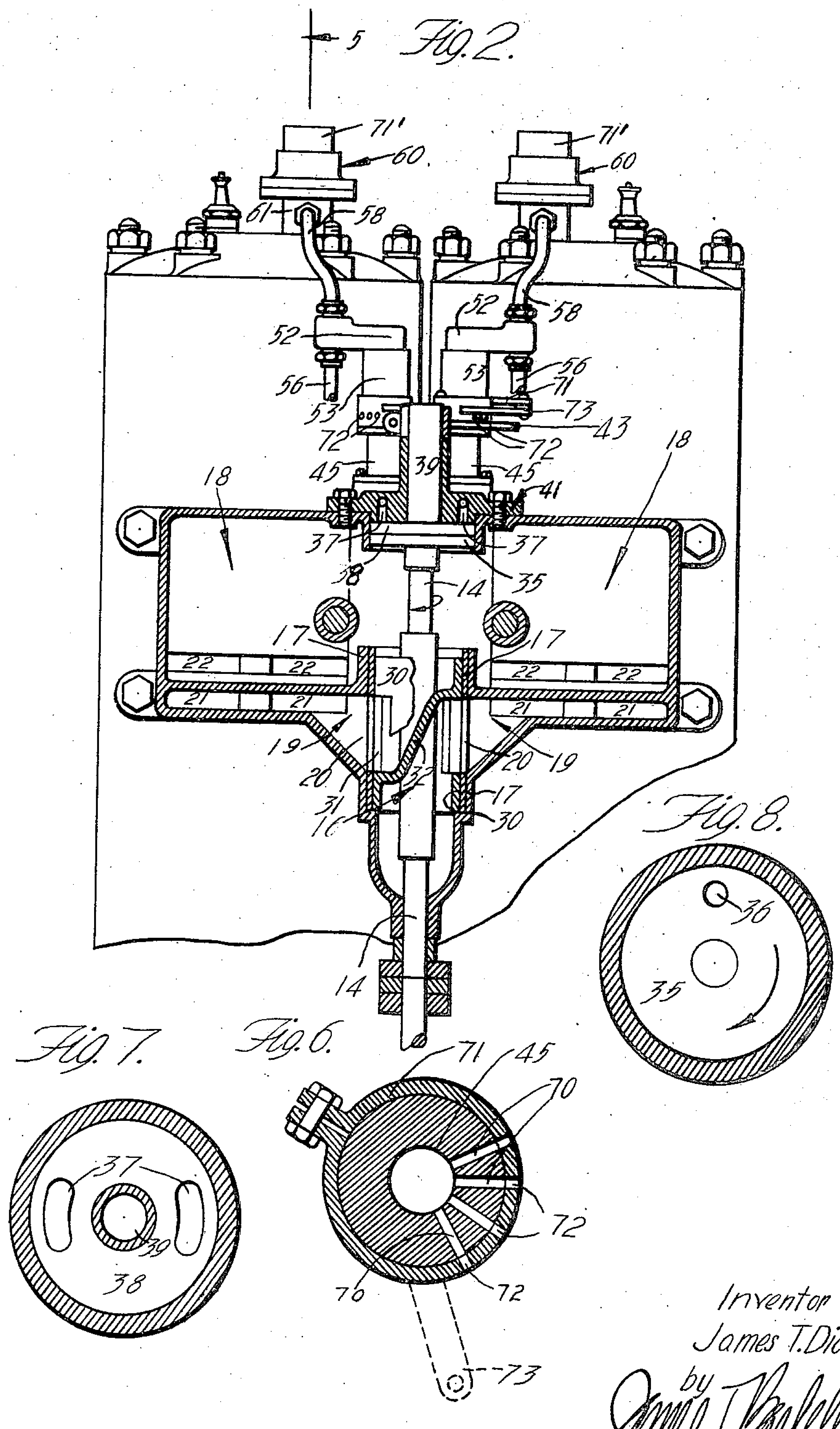

Inventor
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by
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Fig. 3.

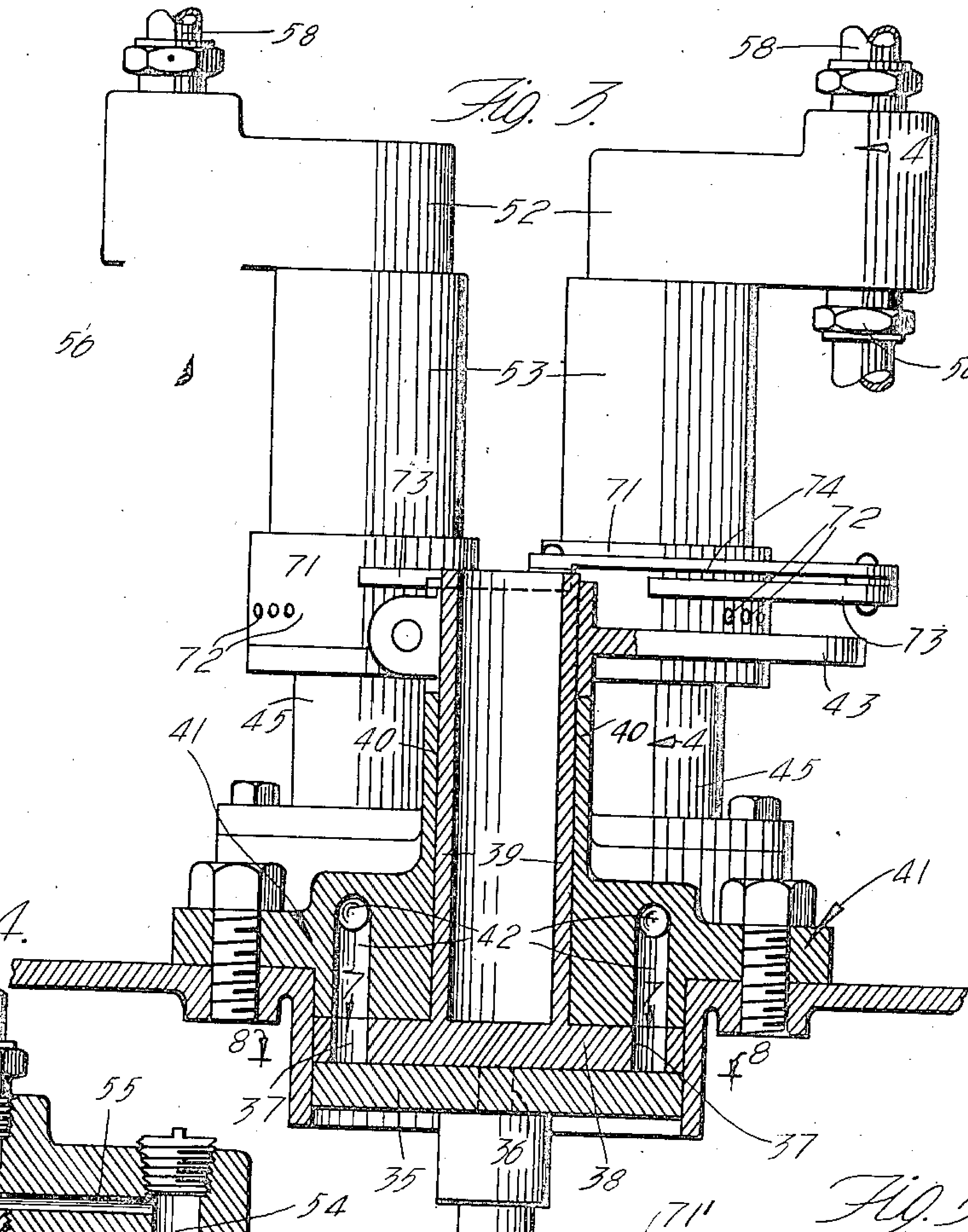


Fig. 4.

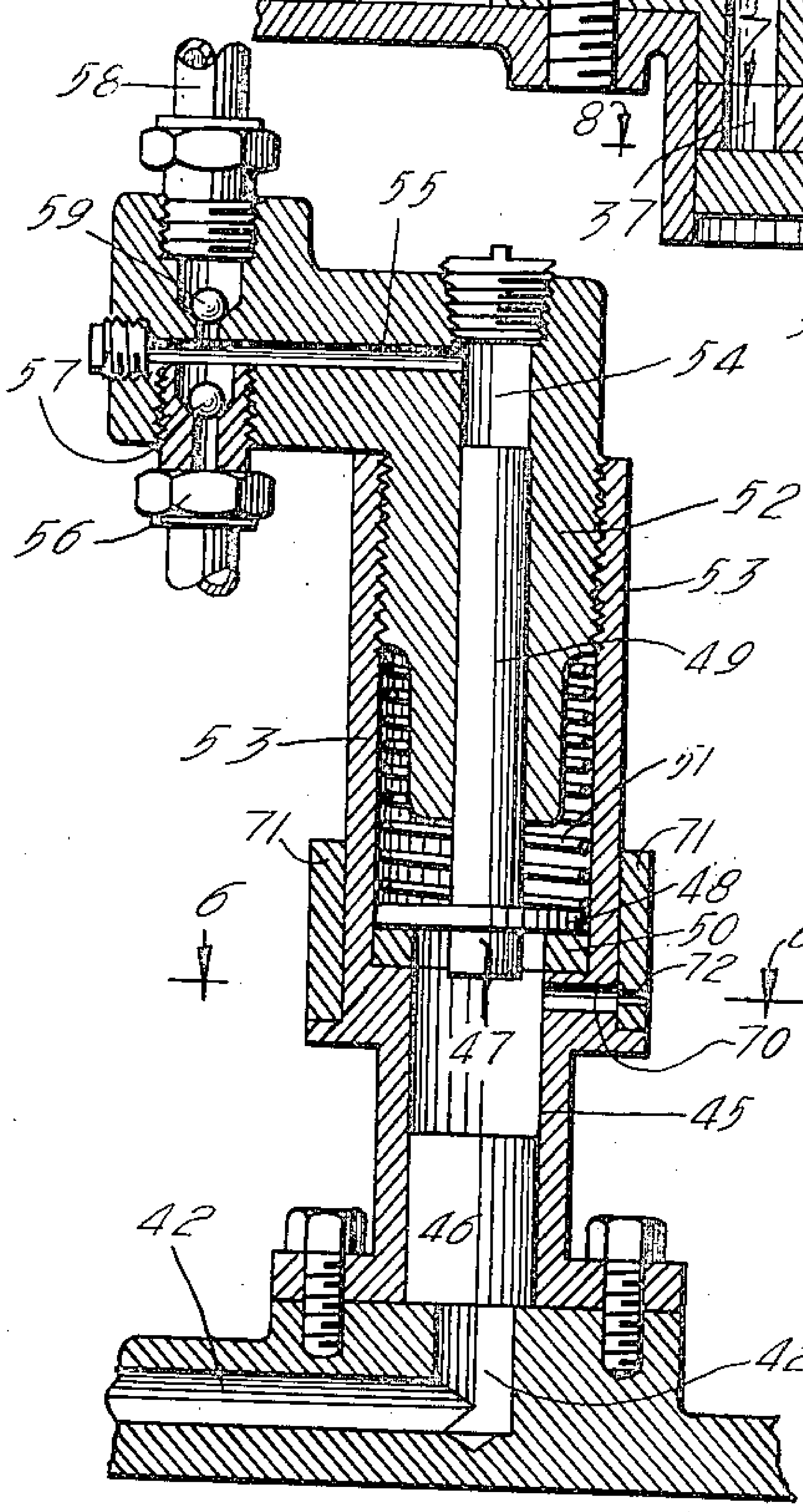
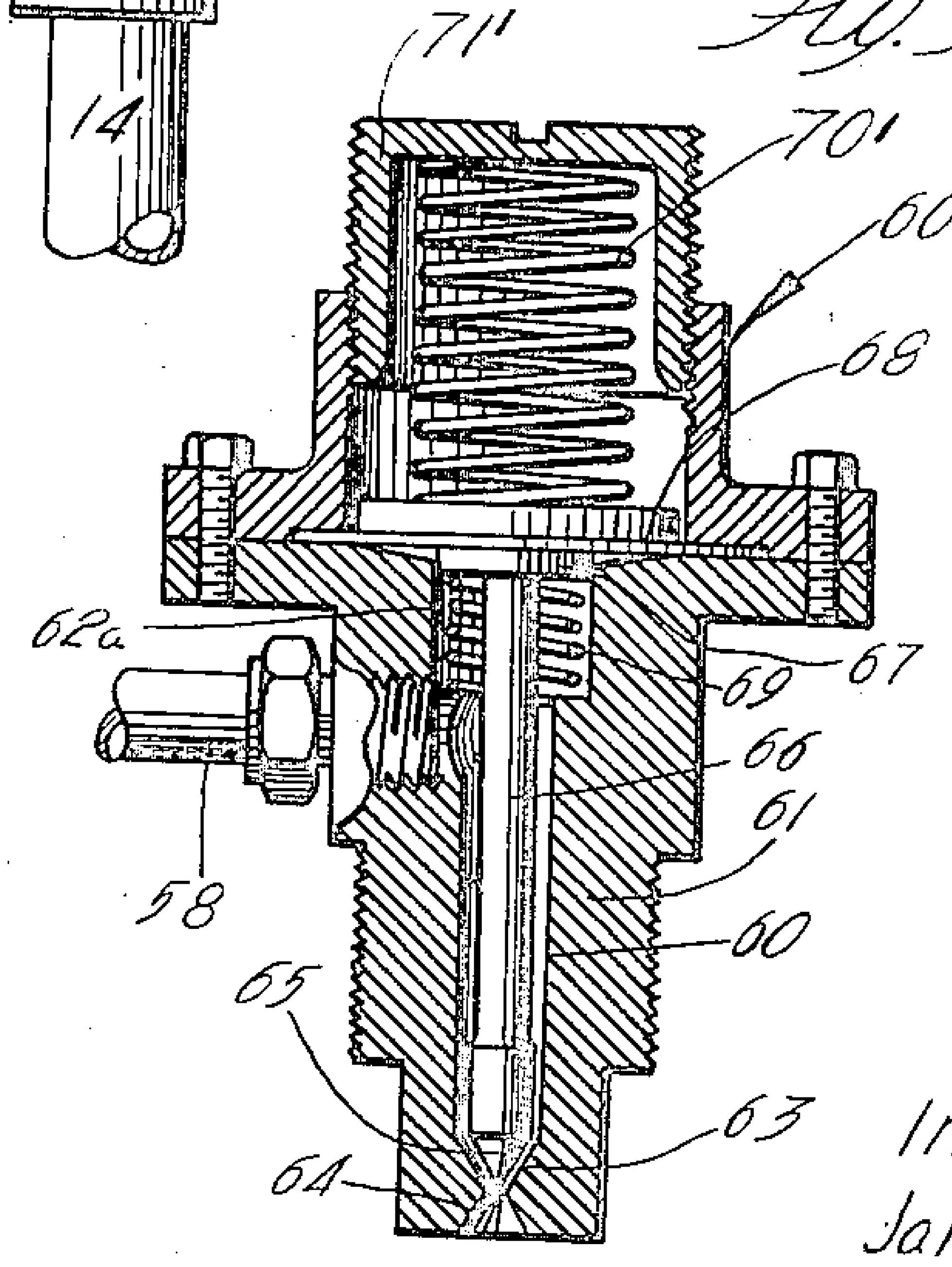


Fig. 5.



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Patented Jan. 2, 1923. 1,440,913

UNITED STATES PATENT OFFICE.

JAMES T. DICKSON, OF LOS ANGELES, CALIFORNIA.

INJECTION MECHANISM FOR INTERNAL-COMBUSTION ENGINES.

Application filed February 4, 1919. Serial No. 274,837.

To all whom it may concern:

Be it known that I, JAMES T. DICKSON, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles, State of California, have invented new and useful Improvements in Injection Mechanism for Internal-Combustion Engines, of which the following is a specification.

This invention relates to fuel injection or similar mechanisms for internal combustion engines and the like; and the object of the invention is the provision of a simple, efficient and accurately operating form of fuel injection mechanism for general use upon internal combustion engines. I explain my invention in connection with a certain type of internal combustion engine which is set forth in my Patent No. 1,128,234, dated February 9th, 1915; and it is a minor or specific object of the invention to provide a fuel injection means particularly applicable to an engine of that type; although my invention is not necessarily limited to such combination.

It is a general feature of my invention that I utilize a fluid fuel pump which is operated by impact of such a member as a plunger or striker. Control of the amount of fuel injected upon each operation is had by controlling the impact of the striking plunger; and the striking plunger is actuated by fluid pressure. In combination with an engine of the character here described I actuate the striking plunger by air pressure which is raised by the charge compression mechanism of the engine; but this feature is of course specific only to the particular embodiment of my invention here described. The invention itself will be best understood from the following detailed description of said particular embodiment thereof; reference being had for this purpose to the accompanying drawings in which—

Fig. 1 is a vertical transverse section showing an engine equipped with my improved fuel injection mechanism; Fig. 2 is a partial side elevation and section taken as indicated by line 2—2 on Fig. 1; Fig. 3 is an enlargement of a portion of Fig. 2; Fig. 4 is a detail section taken as indicated by line 4—4 on Fig. 3; Fig. 5 is a detail section taken as indicated by line 5 on Fig. 2; Fig. 6 is an enlarged detail section of an injection valve, said section being taken as indicated by line 6—6 on Fig. 4; Fig. 7 is a detail section taken as indicated by line 7—7 on Fig. 3; and Fig. 8 is a detail section taken as indicated by line 8—8 on Fig. 3.

For the purposes of this description I will first explain in detail the particular form of engine herein shown. I utilize a trunk cylinder having a small part 10 and a large part 11 operating in the upper work cylinder 12 and the lower air compression cylinder 13, respectively. This particular engine operates on the two-cycle principle. A vertical valve shaft 14 is driven by gears 15 from the crank shaft at even speed with the crank shaft; and this valve shaft 14 drives a rotary valve 16 in a valve casing 17. This valve casing 17 forms a part of a casting which encloses an air storage chamber 18 and air passages 19 which lead from ports 20 of the valve casing to ports 21 which lead into the lower air compression cylinder 13. Charging ports 22 lead from the upper air storage chamber 18 to the upper cylinders 12 and are uncovered by the piston 10 in the lower part of its movement, to admit air charge under pressure to the cylinder. The valve 16 has a cylindrical body 30 with two lateral ports 31 adapted to register with ports 20. Both ends of the cylindrical valve body are open, the lower open end communicating with the air intake passage through which air is drawn from atmosphere and the upper open end communicating with the chamber 18. These two open ends, however, are cut off from each other by a diagonal wall 32, which wall causes one of the ports 31 to communicate with the lower open end of the valve and the other port 31 to communicate exclusively with the upper open end of the valve. As the valve rotates, at even speed with the crank-shaft it will be obvious that once in every revolution of the engine the valve connects each cylinder 13 with the chamber 18 (and this is arranged to be on the up-stroke of piston 11) and then, during the down stroke of each piston 11, the valve connects the cylinder 13 with the intake passage so that the cylinder and piston draw in fresh air. The function of the valve mechanism and of pistons 11 in cylinder 13, is seen to be to compress air into the chamber 18; and this compressed air is admitted to the work cylinders through the ports 22 at the proper time and at the proper position of the piston 10. The two cranks 28 and 29 of the two piston and cylinder elements of an engine unit are placed in opposition to each other, as is indicated in Fig. 1; so that the cylinders of the two elements travel oppositely to each other. Thus, in such a construction as herein described, it will be seen that the highest pressure in chamber 18 will be reached when a cylinder 11 is nearing the uppermost point of its stroke, and just as the cylinder 10 of the other element uncovers its port 22 to take air from the chamber 18. In this specific embodiment of my invention, the fuel injection mechanism is operated by the air pressure in chamber 18; and I make my arrangements such that the injection mechanism is operated by that air pressure when it is at or near its highest point. I shall now describe the fuel injection mechanism in detail.

The valve shaft 14 extends on upwardly through the chamber 18 and at its upper end it carries a distributor disk 35 having a single port 36 which is adapted to register successively with elongated ports 37 in a timer disk 38 directly above the distributor disk. Timer disk 38 is mounted upon a hollow sleeve shaft 39 which is carried in a bearing sleeve 40 of a casting 41 which has ports 42 therein registering with the ports 37 in disk 38. The ports 37 and ports 42 are arranged diametrically opposite each other; and the exact position of ports 37, and therefore the exact time at which port 36 admits air pressure to the ports 42, is adjustable by rotating the disk 38. This rotation may be effected through the medium of a control arm 43 mounted upon the upper end of the sleeve 39.

Each port 42 leads to the lower end of a small cylinder 45 which contains the striking plunger 46; the periodic admission of air under plunger 46 causing the upward movement of that plunger. When the plunger moves upwardly it strikes a projection 47 extending downwardly from the under side of a disk 48. Projection 47 may be in effect a part of pump plunger 49 which extends below the disk 48, the disk being integral with the plunger. Disk 48 normally seats upon a cushion ring 50, which may be of any suitable material, say fibre; and a spring 51 presses down on disk 48 to hold it down. The upper end of the spring bears against a plug 52 which is screw-threaded into the cylinder 53; the screw-threads allowing adjustment of the plug and adjustment of the pressure exerted by spring 51 upon disk 48. The spring 51 thus normally holds pump plunger 49 down with an adjustable pressure. The plug 52 contains bore 54 for the plunger 49; and a port 55 communicates with the upper end of this bore. An inlet pipe 56 communicates with port 55 and the inlet is controlled by an inwardly opening ball check valve 57; and an outlet pipe 58 communicates also with port 55, the outlet being controlled by an outwardly opening ball check valve 59. Fuel is fed to the inlet pipe 56 from any suitable source under suitable head; and the pipe 58 leads to a fuel injection valve 63 which is set in the head of the engine cylinder.

Valve 63 is shown in detail in Fig. 5. A valve body 61 is provided which projects through the wall of the cylinder. Within this body there is a bore 62 terminating at its inner end in a conical valve seat 63. The opening at the end of the valve seat communicates with an expanding nozzle bore 64 through which the jet of fluid is sprayed into the engine cylinder. A conical valve 65 normally rests upon seat 63. This valve has a stem 66 upon whose upper end there is a head 67 which bears against diaphragm 68. The head is pressed lightly up against the diaphragm by a small spring 69 and the diaphragm and the head are pressed down by a heavier spring 70 which is confined under an adjustable plug 71. The pressure of spring 70 is adjusted so that the pressure of the fluid entering through pipe 58 into the enlarged bore 62^a, will be sufficient, when it acts upon the under side of diaphragm 68, to allow valve 65 to raise very slightly off its seat; a very thin film of fuel being thus allowed to pass around the conical valve 65 and into the conical nozzle opening 64. This thin film is sprayed in a cone-shaped spray into the engine cylinder and almost instantaneously vaporizes in the air charge which has previously been drawn into that cylinder and which has been compressed. The head 67 fits loosely in the bore 62^a so that the fuel pressure may have free access to the underside of diaphragm 68.

Now the parts are so arranged with reference to the periods of operation of the engine that the upward striking movement of plunger 46 takes place as the corresponding engine piston approaches the upper end of its stroke. Depending upon how fast the engine is running, and upon the grade of fuel used, the timer disk 38 will be regulated in position to cause the striker plungers 46 to strike the pump plungers 49 at times more or less advanced ahead of, or synchronous with the times when the engine pistons reach the upper limits of their strokes. The sizes of the ports 36, 37, etc., are such as to allow ample air pressure to act upon striker plunger 46 during an ample time period to make that striker plunger move upwardly with sufficient force to strike the plunger 49 forcibly enough to cause that plunger to quickly force through the spray nozzle a sufficient charge for maximum duty operation of the engine. It is a feature of my fuel injection mechanism that the actual injection of fuel is almost instantaneous;

and in varying the amount of fuel delivered to the engine cylinders I do not to any extent vary the length of time consumed in introducing that fuel to the cylinders. I vary the amount of fuel introduced in each charge by controlling and varying the force with which plunger 46 strikes plunger 49. I prefer not to vary the impact energy of plunger 46 by varying the opening through the ports 36, 37, etc. (the ports 37 in their adjustment are always kept in full registry with the ports 42), but I prefer to vary the impact by more or less opposing or retarding upward movement of the plunger 46. By partially opposing and cushioning the upward movement of the plunger 46 I of course regulate the force with which that plunger strikes plunger 49 and consequently regulate the amount by which plunger 49 moves upwardly; and my method of regulation I find to be preferable and superior to any method of regulation which would use an adjustable positive stop to the upward movement of plunger 49, because my method does not impose a sudden stop or shock upon any of the mechanisms. In the cylinder 45 I form relief ports 70 of sufficient size to allow practically free escape of air above plunger 46 and therefore to allow, when these ports are unrestricted, the plunger 46 to strike plunger 49 with full force. I put around the cylinder 53 a movable restriction ring 71 which has therein a plurality of openings 72 therein, which may be brought wholly or partially into register with ports 70. The rings 71 have arms 73 projecting therefrom, and the two arms 73 may be joined together by a connecting link 74 so that both fuel injection mechanisms are controlled together. By placing the openings 72 in minimum partial register with ports 70, and thus choking ports 70, it is possible to so cushion the upward action of plunger 46 as to make that plunger strike the plunger 49 with the minimum force and inject a minimum quantity of fuel for light or idle running of the engine.

There are several peculiarly advantageous features in the operation of my fuel injection device itself and also in its operation in combination with such engine as herein described. And there are certain advantageous features involved in the impulse actuated fuel pumping means itself and also in the combination of this means with such a fuel injection valve as I have described. Certain of these advantages and features will of course be apparent from the foregoing description; the simplicity of the whole mechanism itself and in combination with an engine of the type described, the accuracy and reliability of its action, the advantages accruing from the impulse action, due to its almost instantaneous injection of fuel; all of these advantageous features will be readily understood. There is, however, another feature of operation which I may particularly refer to. It will be noted that the fuel injection valve will only open when a certain fuel pressure is reached. (The pressure on the valve is of course enough to keep it from being opened by any pressure which arises in the engine cylinder). The pressure at which the fuel injection valve opens is adjustable. There is also an adjustable spring pressure opposing movement of the pump plunger; and the striker plunger must first of all strike the pump plunger with enough force to overcome the opposing spring before the pump plunger will move at all to pump the fuel. And then, in addition to that the striker plunger must strike the pump plunger with enough additional force to raise the injection valve. Now the injection valve spring is adjusted primarily for the purpose of obtaining just the right amount of opening to properly spray the fuel; and the pump plunger spring is adjusted to suit the force with which the striker plunger strikes it. Due to this general mode of arrangement and adjustment there is no excessive delicacy of operation in the whole mechanism. The initial or full force of the striker plunger is comparatively large; and it is controlled by cushioning the action of that plunger; but even when cushioned down to its minimum impact, the striker plunger still delivers some considerable energy to the pump plunger. And due to all these facts the operation of the whole device is uniform and reliable even when operating to deliver the minimum fuel charge. This feature of my invention I regard as being of importance; it provides for the positive, quick injection of the fuel charge in uniform regulable quantity without any uncontrolled variation such as is prevalent in many fuel injection mechanisms especially when injecting the minimum charge.

In an engine of the character herein described, the pressure of the compressed charge in chamber 18 rises to a maximum about the time the fuel is injected into one of the cylinders; and as I have hereinbefore stated, the impact plunger is actuated in its striking movement by this maximum pressure. But just as this maximum pressure is reached the charging port of the other cylinder is opened and the compressed charge rushes into that cylinder. The pressure in the storage chamber immediately falls; and it falls more or less dependent on design of the engine and working conditions. At any rate, the pressure falls to a point insufficient to support plunger 46; and plunger 46 then falls. Of course the initial downward movement of plunger 46 is caused by the immediate downward action of the spring 51 and plunger 49. The fluid pressure on plunger 46 may never be, of itself, sufficient to move plunger 49 upwardly; it is the impact which moves that plunger upwardly. The impact having moved plunger 49 upwardly, then the rebound of that plunger starts plunger 46 in its return movement. If the pressure under plunger 46 then immediately falls, plunger 46 will continue its downward movement and immediately come back to its lowermost position. But the impact movement and the return movement of the plunger consume an appreciable time period; and it will be obvious that if the rotary valve mechanism cuts off communication with the storage chamber before the plunger 46 has time to seat, or before the pressure in the chamber falls so as to allow the plunger to return to its normal position, then the impact plunger will not return to its normal position but will be held in some intermediate position by the pressure which is trapped under it. It will thus be seen that the return movement of the striker plunger depends upon the lowering of pressure and upon the length of communication between the plunger cylinder and the storage chamber. This length of communication in comparison to the operation periods of the engine is of course determined by the length of ports 37; and the absolute time period of communication is of course further determined by the speed of the engine. As the engine speeds up, a point will be reached where, due to the inertia and lag in the movement of plunger 46, that plunger will not have time to return entirely to its normal position before communication is cut off; with the result that the next impact stroke of the plunger will be weaker and will consequently cause less fuel to be injected, and thus cause the engine to slow down. Thus, the fuel charge is cut down when the engine over-speeds and the device thus acts like a governor. For a high speed engine the ports 37 will be made longer and for the slow-speed engine the ports 37 will be made shorter. This governing control is an advantageous feature in engines such as marine engines, etc.; it prevents the engine from running away when the load is suddenly released and makes it unnecessary for the engineer to be extremely careful in following the release of the load with the throttle. At the same time it will be seen that I obtain this governing action without the use of any additional or separate mechanism, attaining it with a very simple arrangement of the fuel injection mechanism itself.

Having described a preferred form of my invention, I claim:

1. In a fuel injection mechanism, a fuel pumping element, and fluid pressure operated impact mechanism to actuate said pumping element by impact.

2. In a fuel injection mechanism, a fuel pumping plunger, an impulse plunger adapted to strike the pump plunger, fluid pressure means to cause movement of the impulse plunger, and means yieldingly to oppose the striking action of said impulse plunger.

3. In a fuel injection mechanism, a fuel pumping element, impulse mechanism to actuate said element by striking action, and means opposing the striking action of the impulse mechanism to control and vary the force of its striking action.

4. In a fuel injection mechanism, a fuel pumping plunger, an impulse plunger adapted to strike the pump plunger, and means to cause movement of the impulse plunger, and cushioning means to control the movement of the impulse plunger to control and vary the force with which it strikes the pump plunger.

5. In a fuel injection mechanism, a fuel pumping element, impulse mechanism to actuate said element by striking action, means for actuating the impulse mechanism, and yielding means to control the impulse mechanism to control and vary the force of its striking action, said last mentioned means being independent of the mechanism to actuate the impulse element.

6. In a fuel injection mechanism, a fuel pumping plunger, an impulse plunger adapted to strike the pump plunger, and means to cause movement of the impulse plunger, and yielding means to control the movement of the impulse plunger to control and vary the force with which it strikes the pump plunger, said last mentioned means being independent of the means causing movement of the impulse plunger.

7. In a fuel injection mechanism, the combination of an injection valve, adjustably yielding means opposing the opening of the valve, a fuel pumping element, adjustable yielding means opposing the pumping movement of said element, impulse mechanism to actuate said element by striking action, and means to vary and control the force of striking action of said mechanism.

8. In a fuel injection mechanism, a fuel pump plunger, a spring opposing pumping movement thereof, and controllable fluid pressure actuated striker means to strike the plunger to give it an impulse movement.

9. In a fuel injection mechanism, a fuel pump plunger, a spring opposing pumping movement thereof, a fluid pressure actuated striker plunger to strike the pump plunger, and yielding means to control and vary the force of striking of the striker plunger.

10. In a fuel injection mechanism, a fuel pumping element, fluid pressure operated impact means to operate said pumping element, and means for controlling pneumatically said impact means and varying the action thereof.

11. In a fuel injection mechanism, a fuel pump plunger, a spring opposing pumping movement thereof, a striker plunger to strike the pump plunger, fluid pressure means to actuate the striker plunger, and cushioning means independent of said actuating means and of the pump plunger to control and vary the force of striking of the striker plunger.

12. In a fuel injection mechanism, a structure having a pump cylinder and a striker plunger cylinder therein, a pump plunger in the first mentioned cylinder and a striker plunger in the second mentioned cylinder adapted by movement to strike the end of the pump plunger, and impart to it an impulse movement, a spring opposing such movement of the pump plunger, fluid pressure means to actuate the striker plunger, and pneumatic means in conjunction with the cylinder of the striker plunger to cushion movement of that plunger.

13. In a fuel injection mechanism, a structure having a pump cylinder and a striker plunger cylinder therein, a pump plunger in the first mentioned cylinder and a striker plunger in the second mentioned cylinder adapted by movement to strike the end of the pump plunger, and impart to it an impulse movement, a spring opposing such movement of the pump plunger, fluid pressure means to actuate the striker plunger, and means in conjunction with the cylinder of the striker plunger to oppose movement of that plunger, embodying a relief means from the cylinder between the two plungers, and means to adjustably choke said relief.

14. In combination with an engine having means for compressing a charge of fluid for its work cylinder, a fuel injection device embodying a fuel pump, and impulse mechanism actuated from the fluid pressure raised by the charge compressing means to actuate the fuel pump by striking action.

15. In combination with an engine having means for periodically compressing a fluid and relieving that pressure, a fuel injection mechanism including an impact plunger, and valve means operated in timed relation with the engine to admit the fluid pressure to the plunger to move it at times just before and during the time of pressure relief.

16. In combination with an engine having means for periodically compressing a charge of fluid for its work cylinder and admitting the compressed charge to its work cylinder and thereby relieving the pressure on the compressed charge, a fuel injection mechanism including an impact plunger, and valve means operated in timed relation with the engine to admit the fluid pressure to the plunger to move it at times just before and during the time of pressure relief.

17. In a fuel injection mechanism a cylinder casing, a fuel pump plunger therein and a free striker plunger therein adapted to strike the pump plunger, and an adjustable timing valve adapted to admit fluid pressure behind the striker plunger in adjustable timed periods.

18. In a fuel injection mechanism a cylinder casing, a fuel pump plunger therein and a free striker plunger therein adapted to strike the pump plunger, a timing valve adapted to admit fluid pressure behind the striker plunger, and means to relieve the fluid pressure behind the striker plunger, said means operating in synchronism with the timing valve.

19. In a fuel injection mechanism a cylinder casing, a fuel pump plunger therein and a free striker plunger therein adapted to strike the pump plunger, a timing valve adapted to admit fluid pressure behind the striker plunger, means to periodically compress fluid pressure and to periodically relieve such fluid pressure; said means operating in synchronism with the timing valve and the timing valve admitting such fluid pressure behind the striker plunger before and at the time of pressure relief.

20. In combination with an engine having means for compressing a charge of fluid for its work cylinder, a fuel injection device, embodying a pump plunger, an impulse mechanism embodying an impact plunger adapted to strike the pump plunger, valve means operated in timed relation to the engine to admit the pressure of the compressed charge to the impact plunger to cause it to strike the pump plunger, and means whereby the force of actuation of the impact plunger may be varied independently of the pressure raised by the charge compressing means.

21. In combination with an engine having means for compressing a charge of fluid for its work cylinder, a fuel injection device, embodying a pump plunger, an impulse mechanism embodying an impact plunger adapted to strike the pump plunger, valve means operated in timed relation to the engine to admit the pressure of the compressed charge to the impact plunger to cause it to strike the pump plunger, and adjustable timing means in co-operation with the valve whereby the time of actuation of the impact plunger may be controlled independently of the time of compression by the charge compressing means.

22. In combination with an engine having means for compressing a charge of fluid for its work cylinder, a fuel injection device embodying a fuel pump, actuated from the fluid pressure raised by the charge compressing means of the engine, means whereby the force of actuation of the pump may be varied independently of the pressure raised

by the charge compressing means, and adjustable timing means whereby the time of actuation of the pump may be controlled and adjusted independently of the time of compression of the charge compressing means.

In witness that I claim the foregoing I have hereunto subscribed my name this 11th day of January, 1919.

JAMES T. DICKSON.

Witnesses:
VIRGINIA BERINGER,
VERA JONS.