O. C. DURYEA & M. C. WHITE.

GAS ENGINE.

APPLICATION FILED MAY 24, 1905.

995,062.

Patented June 13, 1911.

5 SHEETS—SHEET 1.

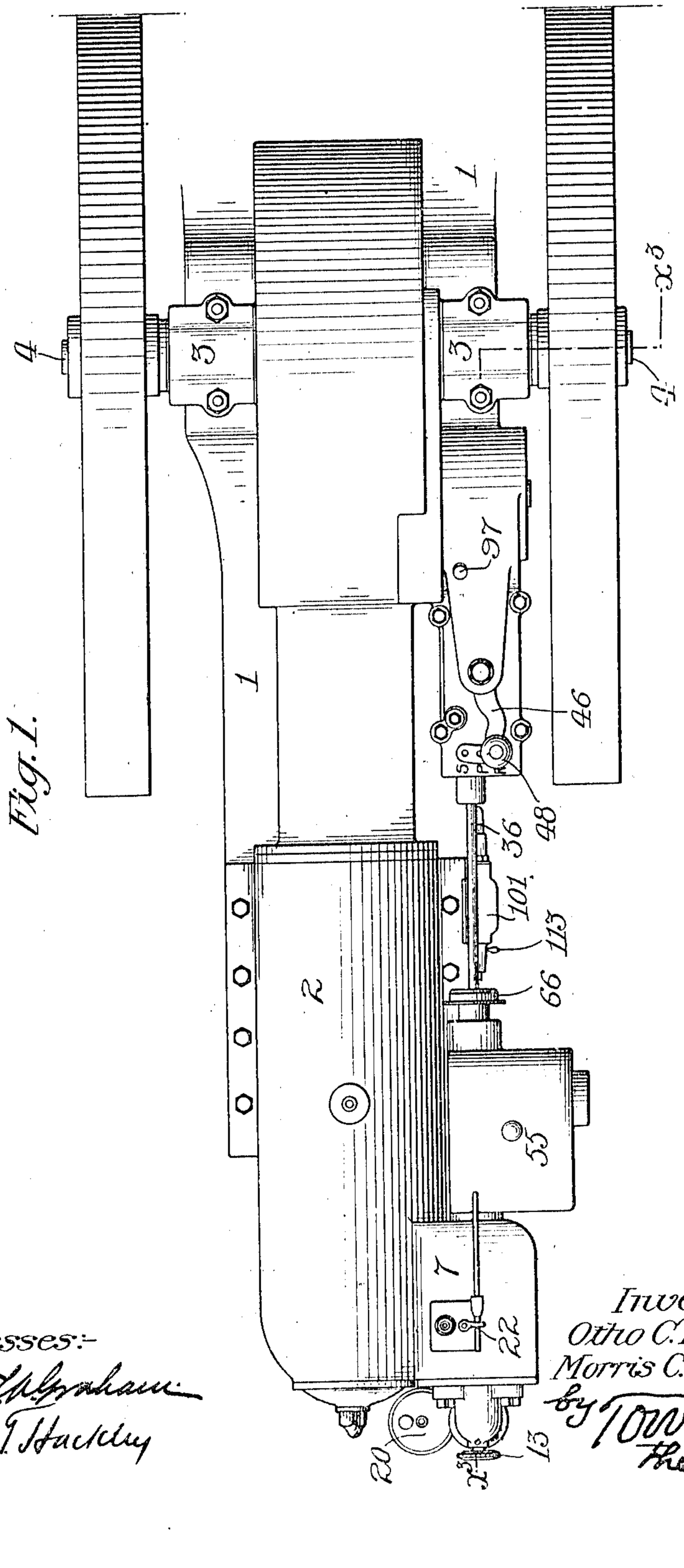

Fig. 1.

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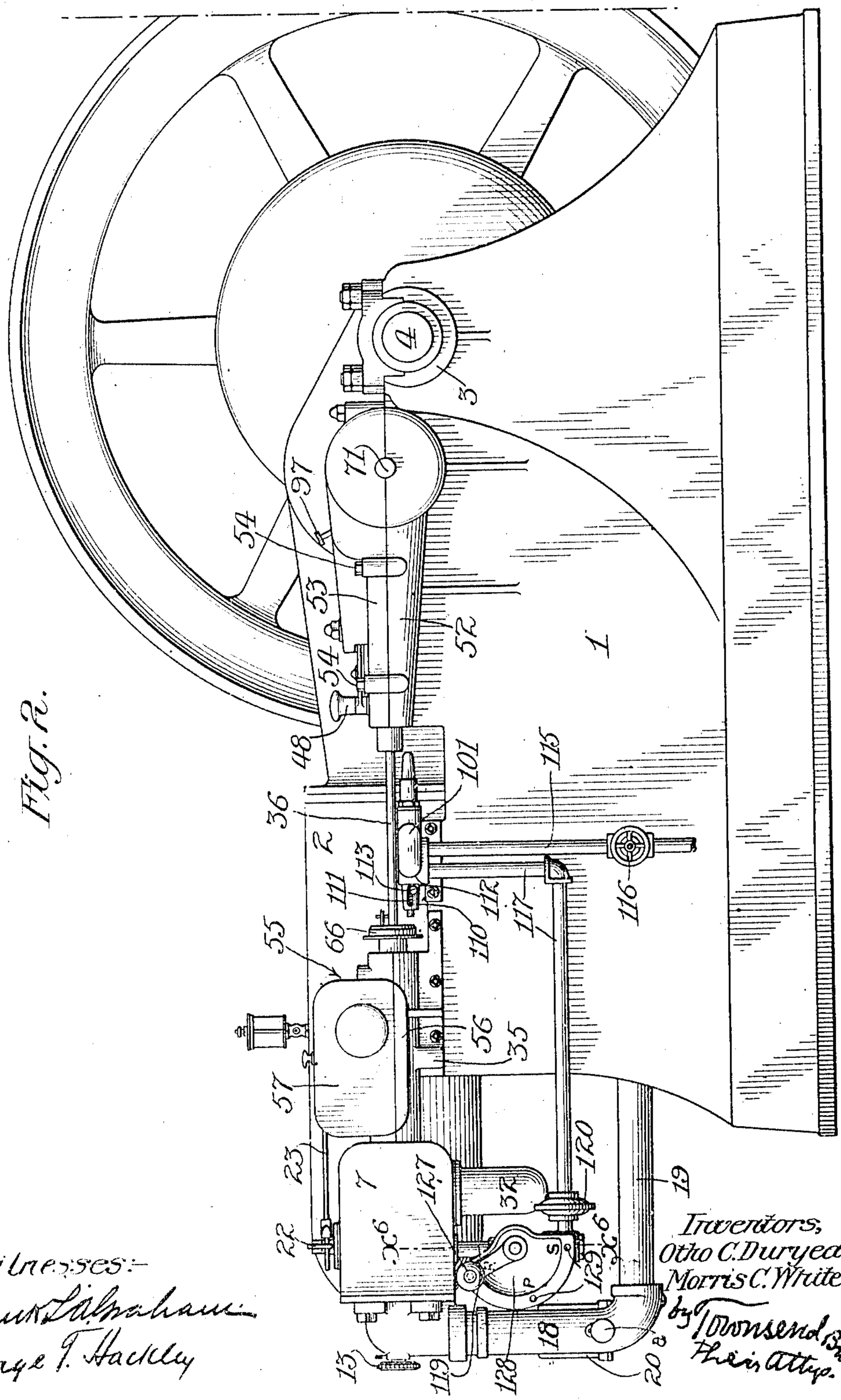

Fig. 2.

Witnesses:-
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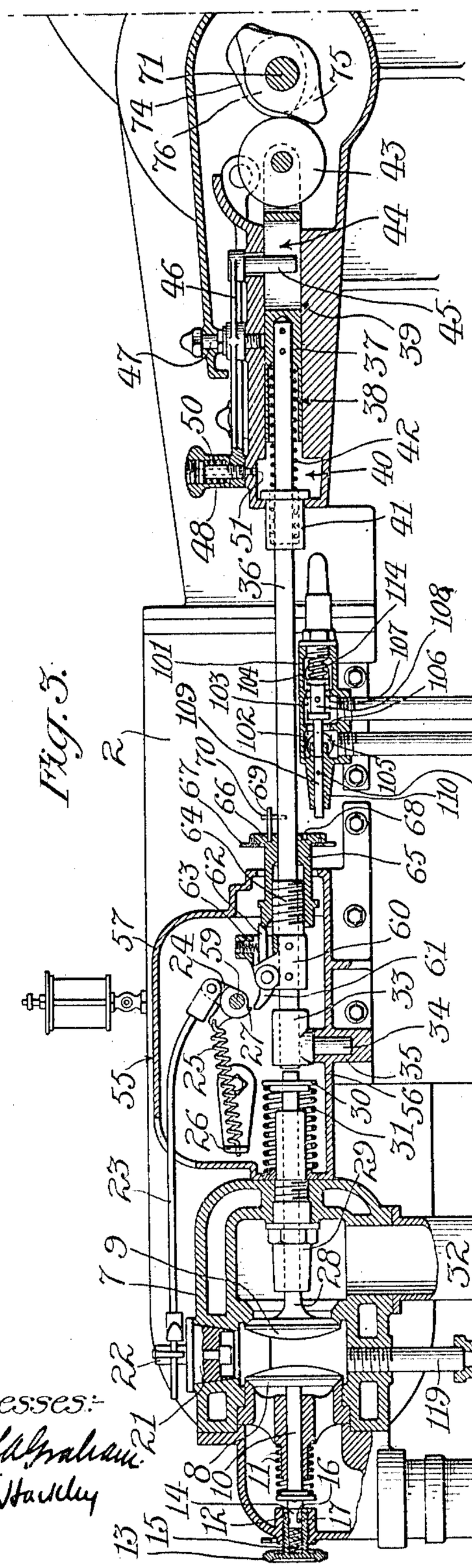
Fig. 3.



Witnesses:-

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5 SHEETS—SHEET 4.

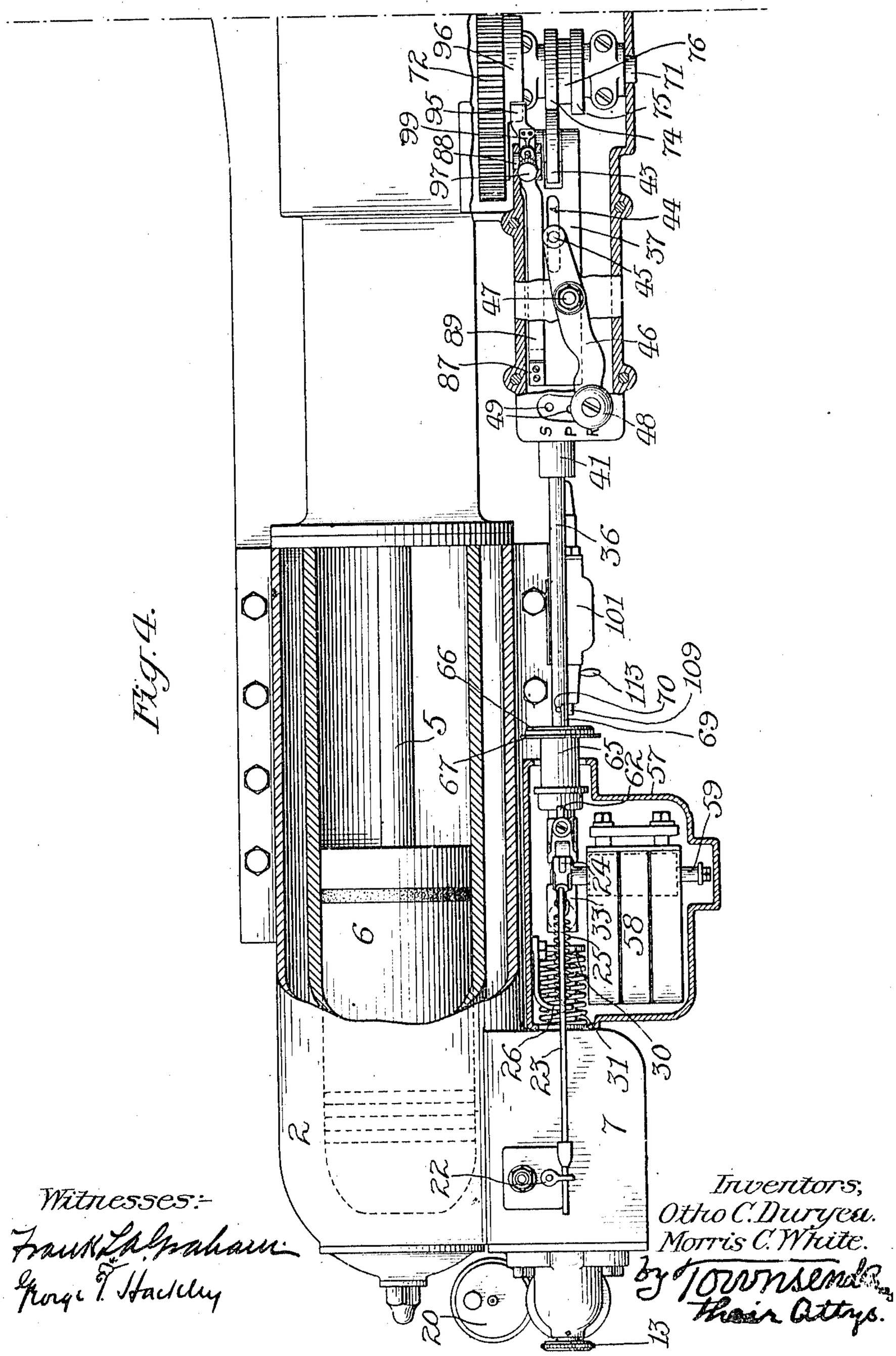

Fig. 4.

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5 SHEETS—SHEET 5.

Fig. 8.

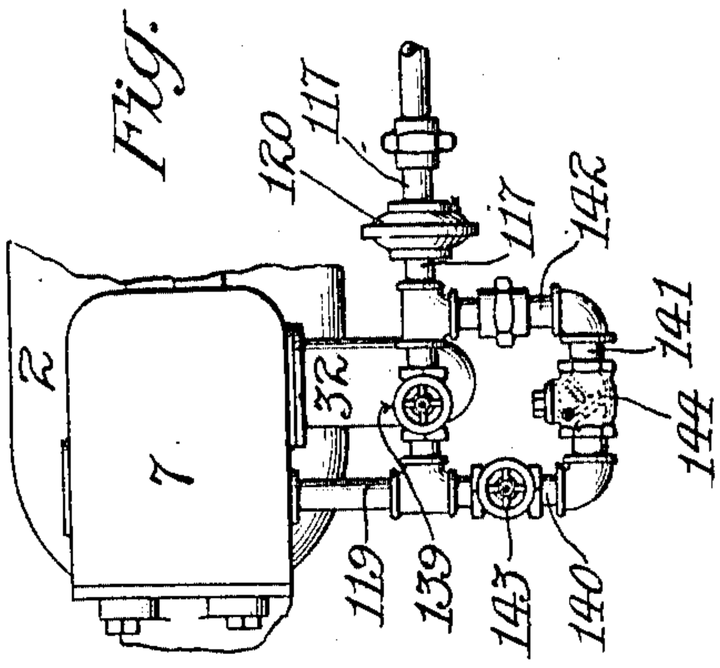


Fig. 7.

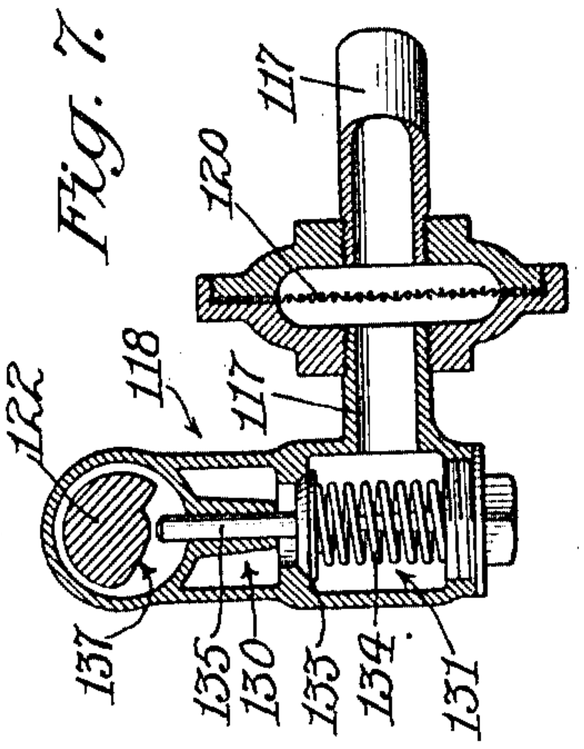
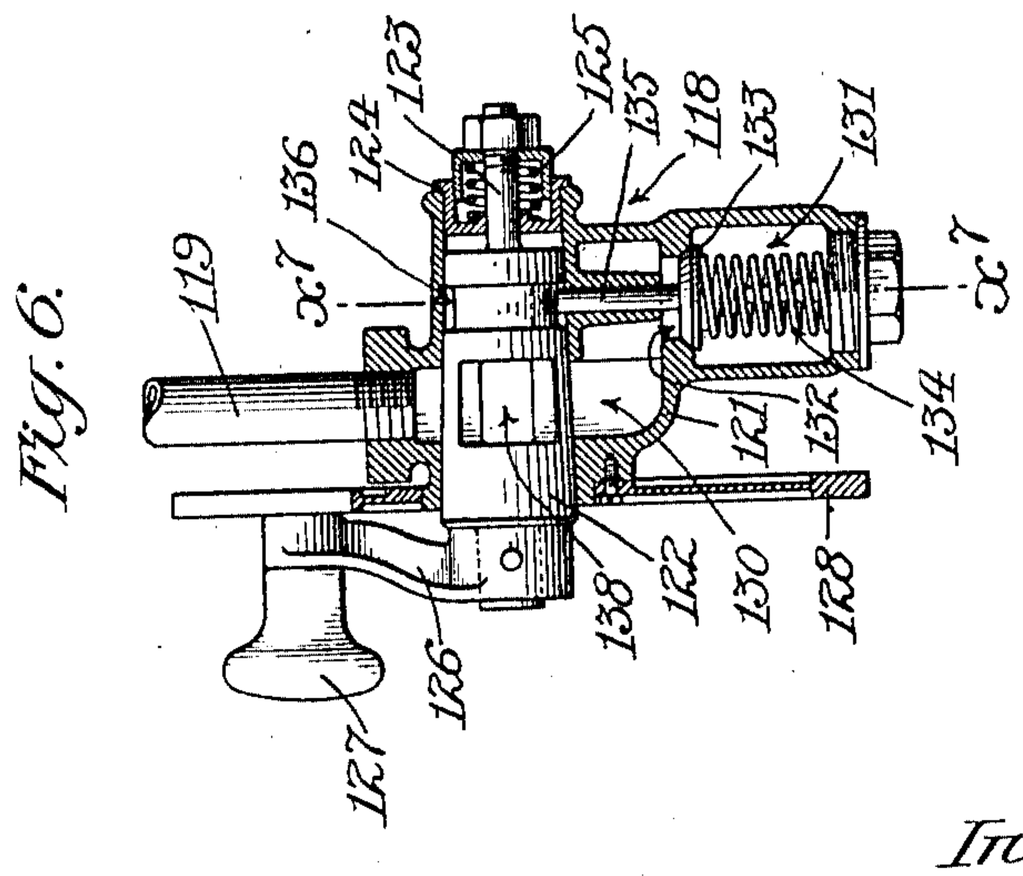


Fig. 6.



Witnesses:-

Frank L. Graham.

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UNITED STATES PATENT OFFICE.

OTHO C. DURYEA AND MORRIS C. WHITE, OF LOS ANGELES, CALIFORNIA, ASSIGNORS TO DURYEA-WHITE MACHINERY COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA.

GAS-ENGINE.

995,062. Specification of Letters Patent. **Patented June 13, 1911.**

Application filed May 24, 1905. Serial No. 261,962.

To all whom it may concern:

Be it known that we, OTHO C. DURYEA and MORRIS C. WHITE, both citizens of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Gas-Engines, of which the following is a specification.

This invention relates to internal combustion engines of the compression type, and the main object of the invention is to provide an engine which, while adapted to operate regularly as an internal-combustion engine, may be operated as a compressing engine to compress air or other gas to form a supply of compressed fluid for subsequently starting the engine, and which is adapted to operate as an air or fluid pressure engine in starting up, preliminary to operating as an internal-combustion engine, the result aimed at being to start the internal-combustion engine by power instead of by hand, and to combine the mechanism for producing all these functions in a unitary mechanism, dispensing with extraneous machines or air compressors, or the like.

Another object is to provide simple, manual controlling elements for regulating the mechanism to accomplish any of the three main functions above set forth, whereby simply the setting of a lever in any one of the three definite positions will convert the engine into any one of the three types mentioned.

Another object is to provide a simple and efficient valve mechanism capable of regulation to perform its duty when the engine operates as an internal-combustion engine, as a pumping engine, or as a fluid-pressure engine.

Another object is to provide a novel and efficient three-way valve which may be set to coöperate with the engine for maintaining the proper flow of compressed fluid which is admitted to the engine when it is acting as a pressure-operated engine; or for regulating the passage of fluid which has been compressed by the engine when operating as a pumping engine or compressor; or which may be placed in condition to permit the engine to operate as an internal-combustion engine.

Another object is to so combine the mechanism of the engine that it is concentrated in compact form and housed and protected from injury, but which is accessible for inspection or regulation when necessary.

Other advantages of the invention will appear in the following description.

The accompanying drawings illustrate the invention, and referring thereto:—

Figure 1 is a plan view of the engine. Fig. 2 is a side elevation of the engine with the nearest fly-wheel removed. Fig. 3 is an enlarged vertical, longitudinal section taken on the line x^3—x^3. Fig. 1. Fig. 4 is an enlarged plan view of what is shown in Fig. 3 with part of the cylinder shown in horizontal section, the magneto-box in horizontal section, and the cam-box partially in horizontal section. Fig. 5 is a side elevation, showing portions of the frame in section, of the governor for controlling the movement of the operating rod. Fig. 6 is a vertical section enlarged through the three-way valve taken on line x^6—x^6, Fig. 2. Fig. 7 is a sectional view on line x^7—x^7, Fig. 6. Fig. 8 is another form of valve mechanism which may be used in place of the form shown in detail in Figs. 6 and 7.

1 designates the base upon which is mounted a cylinder 2, and having journals 3 in which is mounted a crank shaft 4. The crank shaft 4 is connected by a connecting rod 5 with a piston 6 within the cylinder 2.

On one side of the cylinder 2 is an explosion chamber 7 provided with an inlet valve 8 and an exhaust valve 9. The inlet valve 8 has a stem 10, and is held against its seat by a coil spring 11. Screwed in the end wall of the explosion chamber is a threaded bushing 12 having a hand-wheel 13, and slidable within the bushing 12 is a spring-block 14 behind which is a coil compression spring 15. The spring-block 14 has a recess 16 into which a pin 17 projects, the latter extending from the bushing 12. The spring 15 normally holds the spring-block 14 fully extended, and under normal conditions the end of the inlet valve stem 10 rests against the spring-block 14.

In order to facilitate the starting of the engine, the hand-wheel 13 may be turned to advance the bushing and with it the spring-block 14 which will lift the inlet valve from its seat, the spring 15 being stronger than the spring 11, so that some gas will escape while starting the engine, which will allow the engine to be easily started. If the engine is turned over very slowly, all of the gas

will pass out through the valve, and if it is turned over very quickly the pressure will rise sufficiently to compress the spring 15 and shut the valve during compression, after which it will again open. When the spring-block 14 is extended, as above described, the recess 16 permits the retraction of the spring-block during the time that the inlet valve rests upon its seat. As soon as the engine has been started the hand-wheel 13 may be turned back to relieve the valve from the pressure of the spring 15, and it will then operate under normal condition.

An intake pipe 18 is arranged to deliver fuel to the combustion chamber, and has an extension 19 forming an air inlet which preferably extends into the interior of the base 1 to muffle the sound produced by the air as it rushes into the pipe 19 during the intake.

20 designates a vaporizer which may be attached to the pipe 18.

A taper plug 21 is arranged in the upper wall of the explosion chamber 7, and mounted in the plug 21 is an igniter 22 which may be of any preferred construction. The igniter 22 is operated by a rod 23 which is pivoted to one arm of a bell-crank lever 24, a coil spring 25 being attached to the other arm of the bell-crank lever 24 and to a stationary lug 26. The bell-crank lever 24 has a lip 27.

The exhaust valve 9 has a stem 28 which is slidably mounted in a guide 29 which is screwed to the side wall of the explosion chamber 7. The stem 28 carries a spring retainer 30, and a coil spring 31 yieldingly holds the exhaust valve 9 against its seat. An exhaust pipe 32 is connected to the explosion chamber. A block 33 has a stem 34 mounted in a journal 35 and forms a swivel-guide for one end of an operating rod 36, the end of the latter lying adjacent the end of the exhaust valve stem 28. Attached to the other end of the operating rod 36 is a carrier block 37 having a cylindrical recess 38 and being mounted to slide longitudinally or laterally in a guide 39. One end of the guide 39 has a recess 40, and a spring-retaining thimble 41 is arranged in the adjacent end of the guide 39.

A compression spring 42 which encircles the operating rod 36 lies partially within the thimble 41 and recess 38, and serves yieldingly to press the operating rod 36 toward the cam shaft 71. The end of the carrier-block 37 is slotted and carries a roller 43. The carrier-block 37 is provided with a rectangular slot 44 into which projects a pin 45 which is carried by a regulating lever 46 pivoted to a bolt 47, the regulating lever 46 46 being provided with a combined operating and latch handle 48.

The upper face of the guide 39 is provided with three circular recesses 49, of which in Figs. 1 and 4, two only may be seen, the third being obscured by the handle 48. The three recesses 49 are designated S, P, R, the initials respectively standing for "starting", "pumping", and "running". The handle 48 has a vertical movement relative to the lever 46, being yieldingly pressed down against the same by a spring 50, while rigidly attached to the handle 48 is a latch-pin 51 which is adapted to engage with either of the recesses 49.

By lifting the handle 48 and compressing the spring 50, the pin 51 is raised out of its seat in a perforation; the handle may then be swung to bring the pin 51 over another perforation, whereupon the spring 50 expands and draws down the handle 48 and drops the pin 51 into the recess. The handle 48 and the regulating lever 46 may thus be swung into any one of its three positions, and the pin 45 which lies within the slot 44 will accordingly tilt the operating rod 36 upon its fulcrum, the swivel guide 33, the latter swinging freely in the journal 35 to accommodate this lateral movement of the operating rod 36.

The guide 39 is formed of a lower member 52 which is preferably cast integral with the base 1, and of an upper member 53 which is detachably fastened to the lower member 52 by bolts 54, thus forming a removable cover for the carrier-block and adjacent end of the operating rod.

A magneto-box 55 is arranged on the side of the cylinder adjacent the explosion chamber 7, and comprises a lower member 56 which is preferably bolted to the cylinder 2, and an upper member 57 which may preferably be detachably fastened to the lower member, thus forming a housing for the magneto and its adjacent mechanism. Within the magneto-box 55 is a magneto 58, the armature of which is mounted on a shaft 49, the shaft 59 having rigidly attached thereto the bell-crank lever 24, before described.

Pinned on the operating rod 36 is a block 60 to which is pivoted a detent 61 having a rearwardly-extending arm 62, a coil spring 63 bearing upon the top of the arm 62 and serving to tilt the detent 61 upwardly. The block 60 has a threaded stem 64 upon which is screwed a sleeve 65 which has a hand-wheel 66 and a dial 67. The face of the hand-wheel 66 has several recesses 68, either of which is adapted to support a pin 69, there being a pin 70 projecting up from the operating rod 36 against which the pin 69 is adapted to strike. The sleeve 65 forms a timing device and its front edge rests against the undercut end of the arm 62, and the elevation of the detent 61 may be regulated by screwing the timing device along the threaded stem 64, the spring 63 yieldingly holding the arm 62 against the edge of the sleeve 65. The pin 69 may be set

in any position desired on the timing device to regulate its limit of adjustment, and when set in the recess desired it will permit one complete revolution of the timing device, the pin 70 preventing the timing device from being turned beyond that limit in either direction.

The operating rod 36 is reciprocated, as will be hereinafter described; as it moves forward the detent 61 strikes against the lip 27, tilting the bell-crank lever 24, and retracts the rod 23; at a certain point in the forward movement of the operating rod 36 the detent 61 rides out from under the shoulder 27, whereupon the spring 25 reacts and pushes the rod 23 forward, which operates the igniter 22.

Mounted in the frame is a cam shaft 71 which carries a gear 72, and meshing therewith is a pinion 73 which is mounted on the crank shaft 4, the ratio of gearing being two to one. Carried on the cam shaft 73 is a working or running cam 74, a starting cam 75, and an intermediate, concentric pumping roller 76. By means of the regulating lever 46 the operating rod 36, with its carrier block 37, may be swung to bring the roller 43 into working contact with either the running cam 74, pumping roller 76, or starting cam 75.

When the operating rod 36 lies parallel with the cylinder, the roller 43 is directly in line with the running cam 74, as this is the position in which the parts will operate during the greater part of the time. When the roller 43 is resting against either the pumping roller 76 or working against the starting cam 75, the operating rod 36 will stand slightly out of line with the cylinder, but as its radius from the swivel-guide 61 is so great, the angular position of the roller 43 with respect to either the roller 76 or starting cam 75 is immaterial. Moreover, the operating rod 36 operates at this angular position during a very small percentage of time in the operation of the engine.

A trip-plate 87 is arranged on the upper face of the carrier block 37. The guide 39 supports a short shaft 88 to which is pivoted a governor lever 89, the end of which is slightly beveled and is adapted to engage the undercut edge of the trip-plate 87. Fastened to the top of the carrier-block 37 is a flat spring 90 which bears against the under side of the governor-lever 89 and normally holds the latter so that the trip-plate 87 will ride freely under the end of the governor-lever 89 under normal conditions.

Pivoted to the gear 72 are curved weights 91 which are connected by a pair of spiral springs 92 and serve to draw the same toward the center; in order to equalize the movement of the weights 91 they are connected by links 93 to opposite points of a sleeve 94 which is loosely mounted on the cam shaft 71. Fastened to the under side of the governor-lever 89 is a flat spring 95 which is so bent that its free end lies over flanges 96 which project from the weights 91. An adjusting screw 97 passes through an arm 98 formed integral with the trip finger 89 and holds the spring 95 in the desired position relatively to the governor-lever 89, there being a retaining spring 99 which acts against a milled flange 100 on the adjusting screw 97 for holding the latter in the position to which it may be adjusted.

As the gear 72 revolves, the flanges 96 sweep around under the free end of the spring 95. By referring to Fig. 5 it will be noted that each flange 96 is tapering. When the gear 72 revolves at a certain speed, pressure is imparted to the spring 95, which results in overcoming the tension of the spring 90 and depresses the governor-lever 89 so that the trip-plate will strike the end of the governor-lever 89 and prevent the operating rod 36 from retracting.

Arranged on the side of the cylinder 2 is a valve cylinder 101 having chambers 102, 103 and 104, the chamber 104 communicating with the chamber 102 through a passage 105 which lies back of the chamber 103 and does not communicate therewith. Both chambers 102 and 104 communicate directly with the chamber 103 through ports 106 and 107. Arranged within the valve cylinder 101 is a balanced double valve 108 having a stem 109 which projects through an extension 110 of the cylinder 101, the extension 110 having a slot 111 with a notch 112, while a pin 113 in the stem 109 projects into the slot 111 and is adapted to be engaged with the notch 112 to hold the stem 109 and valve 108 retracted so that the ports 106 and 107 are both open. A compression spring 114 is arranged between the rear end of the valve 108 and the adjacent cylinder end and serves to push the valve 108 forward and close the ports 106 and 107 when the pin 113 is lifted out of engagement with the notch 112. Communicating with the chamber 103 is a pipe 115 which is connected with an air tank, not shown, and is provided with a valve 116; while communicating with the chamber 102 is a pipe 117 which is connected with a three-way valve 118, the latter being connected by a pipe 119 with the explosion chamber 7. Connected in the pipe 117 is a strainer 120 shown in detail in Fig. 7.

The three-way valve 118 shown in detail in Figs. 6 and 7 comprises a casing 121 in which is a taper plug 122 having a stem 123 which passes through a pair of telescopic cups 124 within which is a coil compression spring 125 serving to draw the plug 122 closely into its seat. A crank 126 is attached to the plug 122 and is provided with

a handle 127 which may be constructed similarly to the handle 48 before described, and which may be moved over an index-plate 128. The index-plate 128 is provided in the present embodiment with three circular recesses 129, only two of which show in Fig. 2, the other one being obscured by the handle 127.

The casing 121 has a main chamber 130 with which the pipe 119 communicates, and has another chamber 131 with which the pipe 117 communicates. The chambers 130 and 131 communicate with each other through a port 132 which is normally closed by a valve 133, there being a compression spring 134 acting against the bottom of the valve 133 and holding it against its seat. The valve 133 has a stem 135 which lies within a circumferential groove 136 formed in the plug 122, the groove 136 having a cam face 137, so that when the plug 122 stands in the position shown in Fig. 7, the valve 133 is held against its seat by the spring 134; while by turning the plug 122 the cam face 137 will gradually depress the stem 135 and open the valve 133.

The plug 122 has a passage 138 which gives communication of the pipe 119 with the chamber 130 when the handle 127 stands at either P or S; when the handle 127 stands in the position shown in Fig. 2 at R, communication between the pipe 119 and the chamber 130 is cut off.

When the engine is operated by power derived from internal combustion in the cylinder 2, the handle 127 is moved to R, as shown in Fig. 2, thus shutting off communication between the pipe 119 and the chamber 130, as clearly shown in Fig. 3; the valve 108 is also held retracted, the pin 113 engaging in notch 112, as shown in Fig. 2, so that the stem 109 will not be acted upon by the disk 66; the handle 48 is moved into position R, so that the roller 43 coöperates with the running cam 74. As the piston moves through the working stroke, the inlet valve 8 and the exhaust valve 9 are both held against their seats, and the operating rod 36 moves toward the cam shaft 71, being retracted by the spring 42. Upon the return stroke the running cam 74 acting upon the roller 43, pushes forward the operating rod 36, and the end of the operating rod strikes against the end of the exhaust valve stem 28 and pressing the spring 31, opens the exhaust valve 9, thus permitting the exhaust gas to pass out through the pipe 32 as the piston 6 moves toward the head-end of the cylinder. As soon as the piston reaches this end of its stroke the running cam 74 allows the operating rod 36 to be retracted by its spring 42, and the spring 31 expands and closes the exhaust valve 9, and as the piston moves forward it sucks in a supply of fuel through the pipe 18, the inlet-valve 8 opening automatically and remaining open until the end of the suction stroke, and during the return or compression stroke the inlet-valve 8 closes, and as the piston 6 moves toward the head end of the cylinder, it compresses the explosive fuel within the cylinder 2, the operating rod 36 being meanwhile moved forward by the running cam 74, and as soon as the detent 61 strikes the lip 27 it rocks the shaft 59, which gives a partial rotation of the armature of the magneto and simultaneously therewith rocks the bell-crank lever 24 backward, expanding the spring 25 and retracting the rod 23; and as soon as the detent 61 rides from under the lip 27, at which point the position of all of the parts in Fig. 3 are shown, the spring 25 quickly reacts and pushes forward the rod 23, thus operating the igniter 22 and producing a spark in the combustion chamber which ignites the charge; thus, the igniter is not operated until the armature has reached its highest speed and has produced the requisite current; the piston is again moved through the working stroke, the running cam 74 permitting the operating rod 36 to be retracted by the spring 42.

As before stated, the cam shaft 71 revolves at one-half the speed of the crankshaft 4 and the running cam 74 is so timed as to reciprocate the operating rod 36 through alternate long and short strokes, giving it a short stroke, terminating at the point shown in Fig. 3 without coming in contact with the valve stem 28, but sufficiently long to allow the detent 61 to operate the igniting mechanism during the compression stroke; during the exhaust stroke, the running cam 74 advances the operating rod 36 through a much longer stroke and opens the exhaust valve 28 as before described.

When the speed of the engine rises to a certain point the weights 91 move out and their flanges 96, as they ride under the spring 95, depress the governor-lever 89 so that the latter will catch the trip-plate 87 and hold the operating-rod from retracting. This action takes place when the operating rod is in its forward position with exhaust full open and the exhaust valve is thus held open, allowing air to be sucked into and forced out of the cylinder one or more times until the speed of the engine has dropped sufficiently to allow the weights 91 to spring in to permit the spring 90 to raise the governor-lever 89 out of engagement with the trip-plate 87, whereupon the operating-rod 36 is then retracted by the spring 42 and resumes its functions of operating the igniter and exhaust valve at the proper intervals.

By turning the disk 66 so that the pin 69 rests against one side of the pin 70, the detent 61 will be suspended at a relatively low elevation which will allow it to escape from

the lip 27 and thus produce an early spark, while by turning the disk 66 so that the pin 69 rests against the other side of the pin 70, the elevation of the detent 61 will be at a higher point, and it will not therefore escape from the lip 27 as soon, so that a late spark may be produced; while sparks may be produced at intermediate points of the stroke by setting the disk 66 at any point intermediate of these two positions, and by varying the position of the pin 69 in the disk 66 a considerable range of regulation is afforded.

At the close of each run of the engine it is desirable to operate it as a pumping engine or compressor to compress air for starting it for the next run, and during the operation of the engine as a pumping engine, the power is derived from the momentum of the fly-wheels which gives sufficient power for compressing an ample supply of air to be used for starting.

In pumping, the handle 48 is moved to position P, over the middle recess 49, which swings the operating rod 36 on its fulcrum, the swivel-guide 33 placing the roller 43 against the pumping roller 76 so that as the crank shaft is revolved by the momentum of the fly-wheels, the piston 6 is reciprocated, but the operating rod is stationary so that neither the igniter nor exhaust valves are operated. The handle 127 is also placed in position P over the middle recess 129, which while partially turning the plug 122 still affords, by the passage 138, communication of the pipe 119 with the main chamber 130, and thus the valve 133 is yieldingly held closed by the spring 134. The globe valve 116 is opened, but the pin 113 is allowed to remain in engagement with the notch 112 so that the valve 108 is open. As the fly-wheels revolve by their momentum and turn the crank-shaft, the piston as it moves away from the cylinder head creates a suction in the cylinder which causes the inlet-valve 8 to open, the vaporizer 20 of course being shut off in the usual way by closing the needle valve *a*, and air is sucked through the pipes 19 and 18 into the explosion chamber and thence into the cylinder, so that upon the return stroke of the piston the air is compressed, the valve 8 being closed and the air which is thus compressed in the cylinder is forced through the pipe 119, through the passage 138 into the chamber 130, which forces open the valve 133 and passes into the chamber 131, thence through the screen 120 and pipe 117, through the valve-cylinder 103 into the pipe 115, and thence into the usual supply-tank not shown. Upon the return stroke or suction stroke of the piston the air thus forced past the valve 133 is trapped thereby, and the valve 133 remains closed during the suction stroke; upon the compression stroke it again opens and permits the compressed air to pass therethrough and through the connections before described into the tank, which action is repeated so long as the momentum of the fly-wheels is maintained.

A suitable gage, not shown, may be employed for determining when the proper pressure has been produced in the tank. It is preferable to stop the engine after pumping so that the crank stands at about 90° from dead center.

In starting up the engine to operate as an air engine the valve 116 is opened, the pin 113 is lifted out of engagement with the notch 112 and the spring 114 expands and presses the stem 109 against the disk 66. The handle 48 is moved into "starting" position, which tilts the operating rod 36 upon its fulcrum, the swivel-guide 33, placing the roller 43 in coöperation with the starting cam 75. The handle 127 is also moved into position S which turns the plug 122 so that the cam-face 137 presses down the stem 135 and opens the valve 133, and although the plug 122 is thus turned partially, the passage 138 still allows communication between the pipe 119 and the chamber 130. Compressed air from the tank passes through the pipe 115, through the valve-cylinder 103, through the pipe 117, screen 120, past the valve 133, through the port 132, through the passage 138, through the pipe 119 into the explosion chamber, and thence into the cylinder and pushes forward the piston, and the crank shaft is thus operated together with the cam-shaft 71. The starting cam 75 is a double cam, as shown, so that the operating rod 36 is advanced and opens the exhaust valve 9 during each stroke of the piston toward the head end of the cylinder, and the compressed air within the cylinder escapes through the exhaust valve. During each forward movement of the operating rod 36, as the disk 66 is also moved forward, the stem 109 follows the disk, by reason of the expansion of the spring 114, and the valve 108 is thus automatically closed early in each return stroke of the piston, being fully closed as soon as the disk 66 is moved a distance equal to that which the valve 108 must move to close; during the remainder of this stroke the disk 66 moves beyond the end of the stem 109, and the valve 108 remains closed, so that no compressed air is admitted to the cylinder during this exhaust stroke. The momentum of the fly-wheels reverses the movement of the piston when the exhaust stroke has been completed, and as soon as the wing of the starting-cam rides from the roller 43, the spring 42 immediately retracts the operating rod 36 so that the disk 66 presses against the end of the stem 109 and opens the valve 108 early in the stroke, thus admitting compressed air through the valve-

cylinder 103 and connections before described, to the cylinder and forcing the piston forward, which action is repeated until the engine has acquired sufficient momentum, and at that time the valve 133 may be shut by placing the handle 127 in position "R". The handle 48 is then placed in position "R", whereupon as the piston moves out it sucks in the fuel, compresses, ignites, exhausts, and otherwise operates as before described, as an internal combustion engine.

Fig. 8 shows another form of mechanism for use in place of the three-way valve described. In this form the pipe 117 is connected to the pipe 119, there being an ordinary globe-valve 139 in the pipe 117. A by-passage around the valve 139 is provided by pipes 140, 141, and 142, the former having an ordinary globe-valve 143. The pipe 141 has a check-valve 144 which will permit air to pass from the pipe 140 into the pipe 142, but will prevent its passage in the reverse direction. When the engine is operating as an internal-combustion engine, globe valves 139 and 143 are closed. When the engine is pumping, valve 139 is closed and valve 143 is opened, and the air which is compressed in the cylinder of the engine is forced through pipes 119, 140, 141 and 142 into pipe 117, being automatically trapped against passage backward by the check-valve 144. When the engine is being started by the compressed air, the valve 139 is opened and the compressed air flows from the pipe 117 directly into pipe 119 and thence to the engine cylinder, it being obviously immaterial whether the valve 143 is open or shut during this operation.

By using the check valve 133 or 144, it is made possible to secure the starting air pressure without the use of extraneous pumps.

What we claim is:—

1. A cylinder, a piston therein, a shaft, mechanism coöperating with the piston for driving said shaft, valves, cams and a longitudinally and pivotally movable bar operated by said shaft for controlling said valves and thereby causing the piston to operate by internal combustion in said cylinder or by fluid pressure.

2. A cylinder, a piston therein, a shaft, mechanism coöperating with the piston for driving said shaft, valves, cams and a longitudinally and pivotally movable bar operated by said shaft for controlling said valves and thereby causing the piston to operate by internal combustion in the cylinder or to compress fluid in said cylinder.

3. A cylinder, a piston therein, a shaft, mechanism coöperating with the piston for driving said shaft, a series of cams on said shaft, valves, means operated by said cams for controlling said valves and thereby causing the piston to operate by internal combustion in the cylinder, or to compress fluid in the cylinder, or to be operated by fluid pressure in the cylinder, and a valve to regulate the fluid pressure.

4. A cylinder, a piston therein, an exhaust valve for the cylinder, a valve for controlling the admission of fluid pressure to the cylinder, an igniter, a crank shaft coöperating with the piston, a single means operated by the crank shaft for operating both said valves and the igniter, and means for manually varying the operation of said single means.

5. A cylinder, a piston therein, an exhaust valve for the cylinder, a valve for controlling the admission of fluid pressure to the cylinder, an igniter, a magneto, a crank shaft coöperating with the piston, a single means operated by the crank shaft for operating both said valves and the igniter and magneto, and means for manually varying the operation of said single means.

6. A cylinder, a piston therein, an exhaust valve for the cylinder, a valve for controlling the admission of fluid pressure to the cylinder, a check valve between the second valve and the cylinder, manually controlled means for allowing fluid to pass by the check valve toward the cylinder, a crank shaft coöperating with the piston, and means operated by the crank shaft for operating the first two valves.

7. A cylinder, a piston therein, a valve for the cylinder, a cam shaft coöperating with the piston, cams on the cam shaft, a reciprocatory operating rod for actuating the valve, a swivel guide for supporting one end of the operating rod, a carrier block attached to the other end of the operating rod, a guide supporting the carrier block, a spring intermediate the guide and carrier block for retracting the carrier block and operating rod, and means for shifting the carrier block into register with any of the cams.

8. A cylinder, a piston therein, a valve for the cylinder, a cam shaft coöperating with the piston, cams on the cam shaft, a reciprocatory operating rod for actuating the valve, a swivel guide for supporting one end of the operating rod, a carrier block attached to the other end of the operating rod, a guide supporting the carrier block, a spring intermediate the guide and carrier block for retracting the carrier block and operating rod, means for shifting the carrier block into register with any of the cams, and means for engaging the carrier block and preventing retraction of the same when the speed of the cam shaft exceeds a certain point.

9. A cylinder, a piston therein, a valve for the cylinder, a cam shaft coöperating with the piston, cams on the cam shaft, a reciprocatory operating rod intermediate the cam

shaft and valve for actuating the latter, a swivel guide supporting one end of the operating rod, means for swinging said operating rod into register with any of said cams, an igniter, a magneto, mechanism for operating the igniter and magneto, and adjustable means on the operating rod for operating said mechanism.

10. A cylinder, a piston therein, a valve for the cylinder, a cam shaft coöperating with the piston, cams on the cam shaft, a reciprocatory operating rod for actuating the valve, a swivel guide supporting one end of the operating rod, a carrier block attached to the other end of the operating rod, a guide comprising a lower member and a detachable upper member between which the carrier block works, and means carried by the upper block for swinging the carrier block laterally.

In testimony whereof, we have hereunto set our hands at Los Angeles, California this 17th day of May 1905.

OTHO C. DURYEA.
MORRIS C. WHITE.

In presence of—
GEORGE T. HACKLEY,
FREDERICK S. LYON.