No. 762,421. PATENTED JUNE 14, 1904.

A. LEINGARTNER.

COMPOUND GAS ENGINE.

APPLICATION FILED SEPT. 23, 1903.

NO MODEL.

3 SHEETS—SHEET 1.

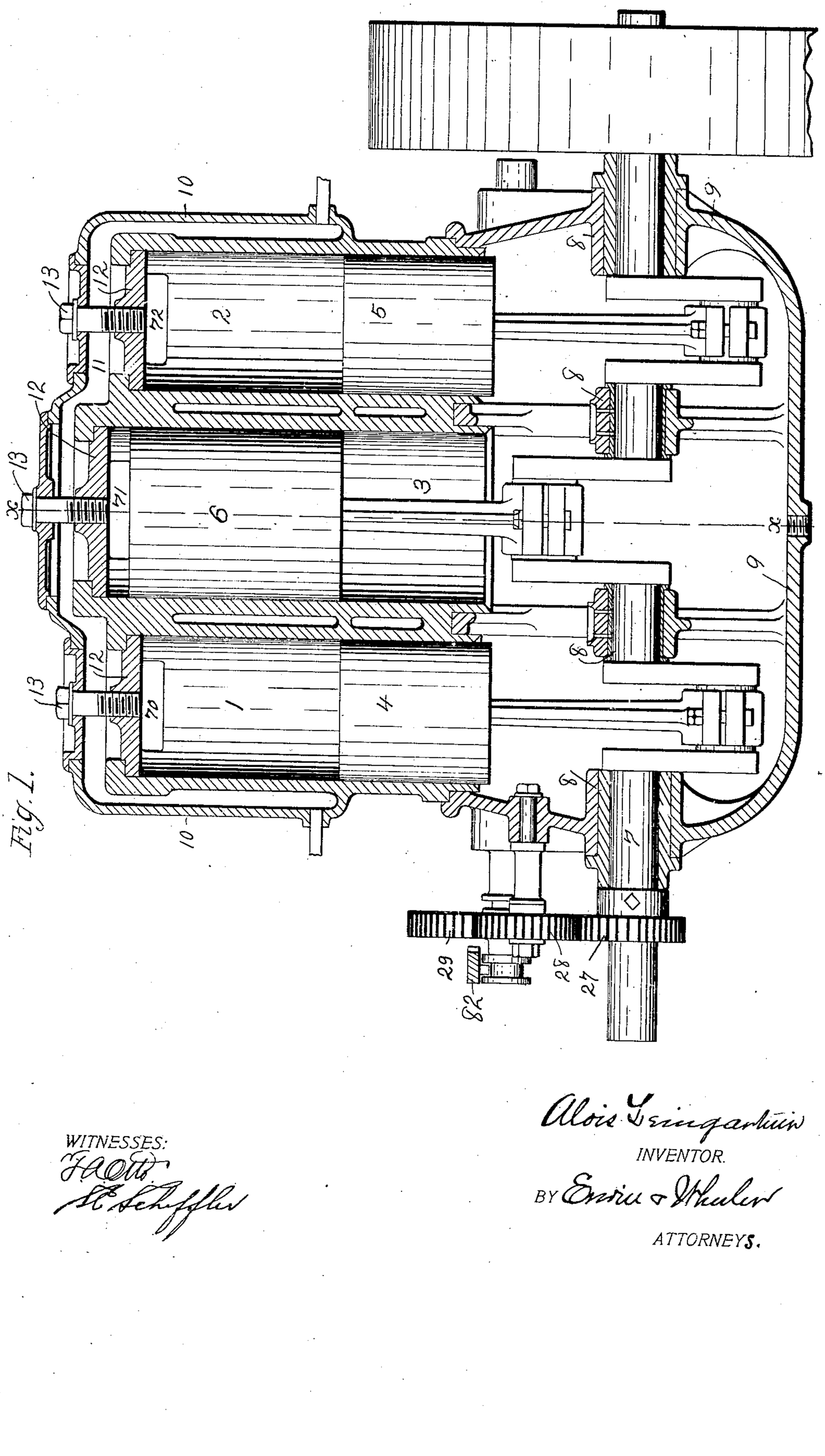

Fig. 1.

WITNESSES:

F. A. Otto

H. C. Schaffler

Alois Leingartner

INVENTOR.

BY Ennis & Thurber

ATTORNEYS.

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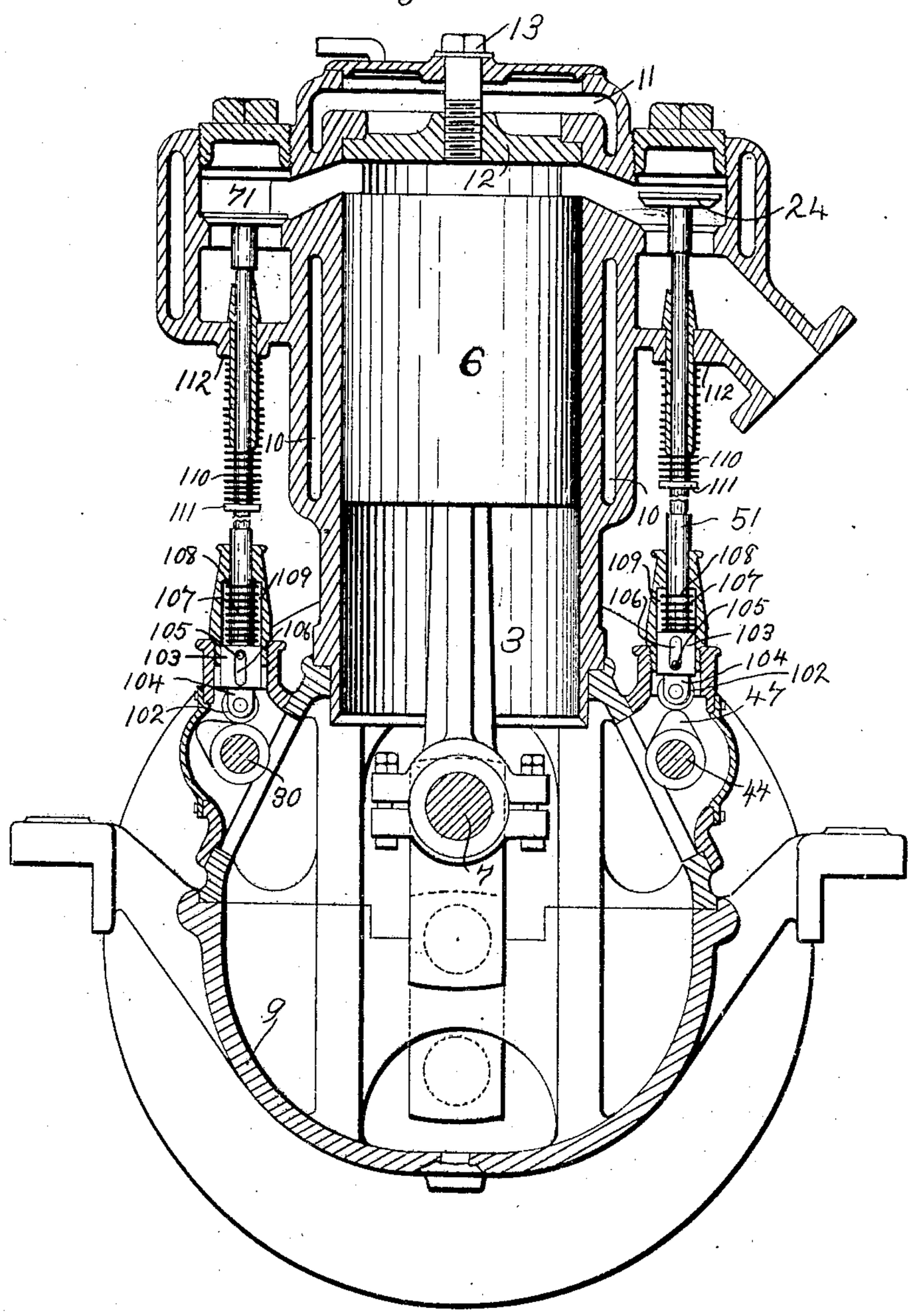
NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2



WITNESSES:

F. A. Otto.

E. L. Schaffer

Alois Leingartner

INVENTOR.

BY Emrich & Dithmar

ATTORNEYS.

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NO MODEL. 3 SHEETS—SHEET 3.

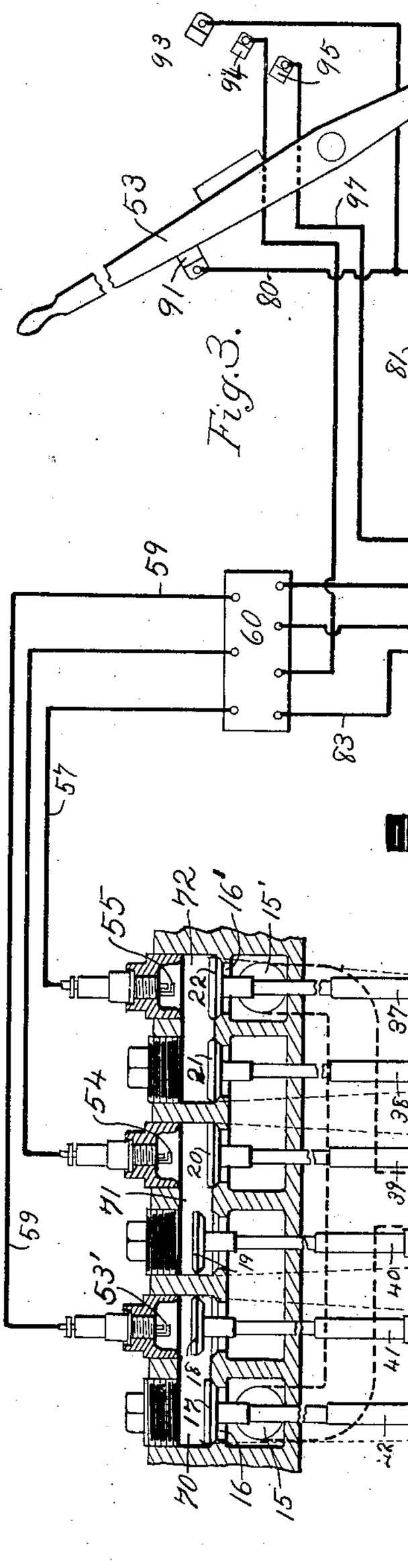

Fig. 3.

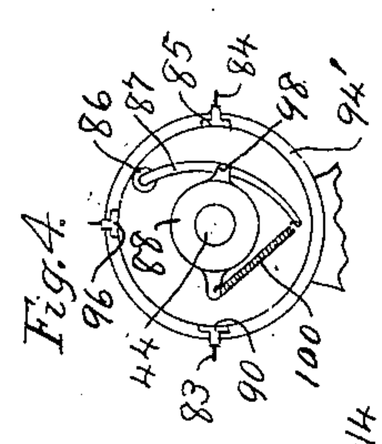

Fig. 4.

Fig. 5.

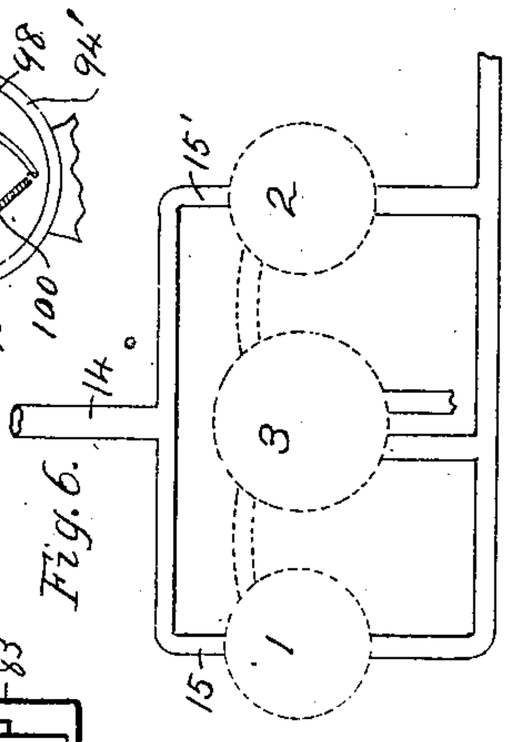

Fig. 6.

WITNESSES:

F. A. Otto.

H. C. Schaffler

Alois Leingartner

INVENTOR.

BY Erwin & Thuler

ATTORNEYS.

No. 762,421. Patented June 14, 1904.

UNITED STATES PATENT OFFICE.

ALOIS LEINGARTNER, OF MILWAUKEE, WISCONSIN.

COMPOUND GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 762,421, dated June 14, 1904.

Application filed September 23, 1903. Serial No. 174,245. (No model.)

To all whom it may concern.

Be it known that I, ALOIS LEINGARTNER, a citizen of Austria, residing at Milwaukee, county of Milwaukee, and State of Wisconsin, have invented new and useful Improvements in Compound Gas-Engines, of which the following is a specification.

My invention relates to improvements in that class of compound gas-engines in which the explosive pressure of the gas from two high-pressure cylinders is caused to exhaust into a third low-pressure cylinder.

The object of my present invention is to provide simple means for converting the engine at will by the movement of a lever from a compound into a single direct-acting engine in which the gas will be received and exploded in all of said cylinders alike and exhaust from said cylinders into the atmosphere direct from each of said cylinders the same as from the cylinder of an ordinary single direct-acting gas-engine, whereby the power of a given engine may at a loss in economic efficiency be greatly increased as circumstances require and whereby when a less power is required the engine may be used as a compound engine with less power and with higher efficiency.

The construction of my engine is explained by reference to the accompanying drawings, in which—

Figure 1 represents a longitudinal vertical section. Fig. 2 is a transverse section drawn on line *x x* of Fig. 1. Fig. 3 is a diagrammatic view in which the valve-rods are shown as if turned down from a vertical to a horizontal position that the relative positions of the several valves to their seats may be better illustrated and understood. Fig. 4 represents a front view of an automatic circuit-closer removed from the engine. Fig. 5 represents a side view of cam 47. Fig. 6 is a diagrammatic view of the cylinders and the ducts and ports leading to and from them.

Like parts are identified by the same reference characters throughout the several views.

1 and 2 are the high-pressure cylinders, into which the gas is alternately admitted and exploded.

3 is a low-pressure cylinder, into which when the engine is used as a compound engine the gas is admitted from the other two high-pressure cylinders alternately with the back movement of the pistons in such cylinders.

It will be understood that when the engine is used as a compound engine and the piston in cylinder 1 is at the upper end of the cylinder the gas is first exploded in such cylinder 1, when with the downward stroke of the piston in such cylinder the piston in the third or low-pressure cylinder, which is attached to the opposite side of the crank-shaft, will be moved upward; that when the piston in the first cylinder has completed its downward stroke and moves upward the gas in such cylinder will be led to the upper end of the third or low-pressure cylinder, whereby the piston in such low-pressure cylinder will be driven down by the expansive action of the gas from the first cylinder; that as the piston in the low-pressure cylinder is thus moved downward the gas and air which have previously been drawn into the second high-pressure cylinder will be compressed and ignited, whereby the second explosion will occur in the second high-pressure cylinder, and as the piston in such second cylinder is driven back by the expansion of the gas therein the piston in the low-pressure cylinder will be again driven upward preparatory to being acted upon by the gas from the second cylinder as the same is driven out by the return stroke of the piston in such second cylinder.

Thus it will be understood that when the explosion takes place in one of said high-pressure cylinders the gas and air are being drawn into the other high-pressure cylinder preparatory to being compressed, and that when the gas which has thus been drawn into the high-pressure cylinder is being compressed the exploded gas in the first-named cylinder is caused to act upon the piston in the low-pressure cylinder upon the opposite side of said crank-shaft, whereby the crank-shaft is actuated upon one side with the low-pressure cylinder with each revolution and upon the opposite side by the pistons in one of said high-pressure cylinders with each alternate revolution. For example, when the piston in the high-pressure cylinder 1 is be-

ing driven down by the exploded gas therein fresh gas and air will be drawn into the other high-pressure cylinder 2 preparatory to being compressed; that with the return of upward stroke of the pistons in said high-pressure cylinders (which is caused by the stroke of the piston in the low-pressure cylinder) the exploded gas in cylinder 1 will pass into the low-pressure cylinder 3, while the gas which has been drawn into the cylinder 2 will be simultaneously compressed; that when the piston in cylinder 2 is driven down by the explosion of the gas which has been thus compressed fresh gas and air will be drawn into cylinder 1 preparatory to being compressed with the upward stroke of the piston in such cylinder. Thus it will be understood that fresh gas and air are alternately drawn into said high-pressure cylinders 1 and 2 as the pistons therein move downwardly and are alternately compressed and exploded in such cylinders as said pistons are moved upwardly with each alternate revolution of the crank-shaft.

4 and 5 represent the pistons in the high-pressure cylinders. 6 represents the piston in the low-pressure cylinder. 7 represents the crank-shaft, which is supported in journal-bearings 8 of ordinary construction from the frame 9. The several cylinders are preferably provided with a water-jacket 10 and a water-chamber 11. 12 represents the heads of the several cylinders, which are secured in place by the retaining-bolts 13. The cylinder 1 communicates with the inlet-gas duct 14 through the branch 15, chamber 16, and chamber 70. The cylinder 2 communicates with said inlet-duct 14 through the branch 15′, chamber 16′, and chamber 72. The mixed gas and air is drawn through said ducts and chambers into said cylinders preparatory to being compressed and exploded therein at the proper moment. The passage of gas and air through the chamber to the respective cylinders is governed by the valves 17, 18, 21, and 22, and the escape of the exploded gas and air from said cylinders is controlled at the proper time through the valves 19 and 20.

Motion is communicated to the inlet-valves 17, 18, 19, 20, 21, and 22, inclusive, from the crank-shaft 7 through the gears 27 28 29, cam-shaft 30, cams 31, 32, 33, 34, 35, and 36, and valve-rods 37, 38, 39, 40, 41, and 42, while motion is communicated from said crank-shaft 7 to the exhaust-valves 23, 24, 25, and 26, inclusive, at the proper time through the gears 27 28 43, cam-shaft 44, cams 45 46 47 48, and valve-stems 49, 50, and 51 and 52. When desirous to use the engine as a compound engine, or, in other words, so that the pressure of the exploded gas and hot air in the high-pressure cylinders, respectively, will exhaust into the low-pressure cylinder, the valve-controlling lever 53 will be thrown into the position indicated in Fig. 3, whereby the cam-shaft 30 will be moved toward the right and the cam-shaft 44 will be moved toward the left.

When the cam-shaft 30 is drawn toward the right, as thus indicated, the cams 34 and 35 will be brought to such a position beneath the valves 18 and 19 as to cause said valves to be simultaneously raised, whereby the gas and air in the high-pressure cylinder 1, which has been drawn in past the valve 17, exploded by a previous stroke, passes into the low-pressure cylinder 3 with the upward stroke of the piston in said cylinder 1, whereby the piston in the cylinder 3 is driven to the lower end of said cylinder.

When the cam-shaft 30 has been revolved half a revolution, the valves 20 and 21 will be raised by the action of the cams 32 and 33, while the valves 18 and 19 will be permitted to close, whereby the expanded gas and air in the high-pressure cylinder 2 will be permitted to exhaust into the said low-pressure cylinder 3, while at the same time fresh gas and air are being drawn into the high-pressure cylinder preparatory to being exploded therein. The valves 17 and 22 are raised at the proper moment to admit the gas with the downstroke of the piston in the cylinders 1 and 2 by the cams 31 and 36, which project at right angles from the other cams on said shaft. In like manner when the explosion takes place in the high-pressure cylinder 1 gas and air are being drawn into the cylinder 2 past the valve 22, which is raised by the action of the cam 31.

It will be understood that when the engine is being thus used as a compound engine owing to the fact that both of the high-pressure cylinders exhaust into the low-pressure cylinder it becomes necessary to operate but one of the exhaust-valves which lead from said high-pressure cylinder. For this reason the cams 45, 46, and 48 are thrown out of operating connection with the several exhaust-valves 23, 25, and 26, while the exhaust-valve 24 only is actuated, motion being communicated to said valve 24 through the cam 47 with each revolution of the cam-shaft 44. The cam 47 is so adjusted as to open the exhaust at the proper moment for permitting the escape of foul gases from the low-pressure cylinder as the same is raised, while the relative positions of the several cams on the shaft 30 are such as to operate the several valves 17 to 22, inclusive, to permit the passage of gas to and from the several cylinders, as stated, at the proper moments.

It will be noticed that the gas-controlling valves 17 and 18 are located in a separate chamber 70 by themselves. The gas-controlling valves 19 and 20 are located in a separate chamber 71 by themselves, and the gas-controlling valves 21 and 22 are also located in a separate chamber 72 by themselves, and that each of said three chambers is provided with separate sparking terminals 53, 54, and 55,

which terminals are connected with an electric battery 56, as hereinafter described.

The gas in the several chambers 70, 71, and 72 is ignited at the proper moment by an electric spark produced in the ordinary way by the several sparking terminals 53′, 54, and 55. When the engine is used as a compound engine, the lever 53 being then in the position shown in Fig. 3, the sparking terminals 54 are thrown out of circuit with the battery, while the electric circuit is formed between the battery 56 and the other two sparking terminals as follows: First, the circuit between the battery 56 and the sparking terminal 53′ is formed through the wire 80, operating-lever 53, connecting-link 81, lever 82, and from thence through the machine to the sparking terminals 53′, thence through the wire 59, sparking coil 60, wire 84, electrode 85, circuit-closing roller 86, lever 87, collar 88, to the shaft 44, thus completing the circuit; second, the circuit between the battery and the sparking terminals 55 is formed in like manner through the connections enumerated, and from the terminals 55 back to the battery, through the wire 57, sparking coil 60, wire 83, electrode 90, roller 86, lever 87, and sleeve 88, to the said shaft 44, thus completing the circuit. It will thus be understood that the same movement of the lever 53 which closes the electric circuit with said terminals in the manner described also moves the respective cam-shafts and cams thereon which govern the movement of the valve.

When desirous to increase the power of the engine, the position of the operating-lever 53 is reversed, whereby the action of the several valves is so changed as to practically convert the engine from a compound to a single-acting engine, when the gas is received in all of said cylinders alike and discharged from all alike into a muffler or the atmosphere, while by such movement of the lever the electric circuit is closed with all of said sparking terminals at the proper moment, corresponding with the movement of the respective pistons. By reversing the position of the lever 53 from that shown the cam-shaft 30 is moved toward the left and the cam-shaft 44 is moved toward the right, whereby the several cams 32, 33, 34, and 35 are shifted so as to be thrown out of operative connection with the several valves 18, 19, 20, and 21, while by the same movement the several other cams 45, 46, 47, and 48 will be thrown into operative connection with the several other valves 23, 24, 25, and 26, whereby the gas will be received into the two high-pressure cylinders 1 and 2 through the valves 17 and 22, respectively, and exhausted therefrom direct to the muffler or atmosphere through the valves 23 and 26, while gas will be received direct from the supply to the larger cylinder 3 through the valve 25 and exhausted therefrom through the valve 24 direct to the atmosphere or muffler.

When the lever 53 is in the position shown, the electric circuit is closed between such lever and the wires leading to the sparking terminals 53 and 55 through the electros 91. When the lever is reversed, it is brought into electric connection with all of said sparking terminals through the electros 93, 94, and 95, and the movement of the automatic circuit-closer is so timed as to close the circuit with said several sparking terminals, so as to ignite the gas in the several cylinders at the proper moment. The circuit-closing roller 86 is brought into electric contact with the sparking terminal 54 through the electros 96. The electros 96 are brought into electric connection with the electros 95 through the wire 97. The roller-supporting lever 87 is pivotally connected with the collar 88 through the pin 98, and the contact-roller 86 is held yieldingly against the inclosing case 94′ by the spring 100. The spring 100 is connected at one end with said lever 87 and at the other end with said collar 88. The respective cam-shafts 30 and 44 are slidably supported in journal-bearings from the main frame of the engine, and they are free to be moved longitudinally therein when changing the position of the valve-actuating cams in relation to the respective valve-rods. The lower ends of the valve-rods are provided with rollers 102, which are adapted to bear upon the respective cams with which they operate.

To provide for opening the several valves with a quick positive movement as the apex of the several cams pass beneath the bearing rollers, I have interposed a slidable bearing-block 103 between the roller-supporting bracket 104 and the valve-rods. The lower ends of the valve-rods are slidably connected with said bearing-blocks in suitable apertures provided therefor by pins 105, which pins are rigidly affixed at their centers to said valve-rods, while their outer ends operate in elongated slots 106, provided therefor in said blocks. The slots 106 permit of a certain lost movement of the bearing-blocks as the roller-supporting brackets are raised by the cam. The blocks are thus moved upward without moving the valve-rods or valves until the lower side of the slot 106 is brought in contact with the pin, when the action of the cam will be brought to bear rigidly against the valve-rod until the valve is raised from its seat against the pressure of the gas in the chamber above it. The bearing-blocks 103 are pressed downwardly, so as to hold the bearing-rollers yieldingly against the cams by the spiral springs 107, which springs are interposed between the respective blocks and the shoulders 108, formed in the spring-inclosing sleeve 109. The several valve-rods are held down against the several bearing-blocks 103 by the spiral springs 110. The springs 110 are interposed

between the collars 111, formed on the periphery of the valve-rods and the stationary sleeves 112, the said springs 107 and 110 being so wound as to be compressed by the upward movement of the valve-rod and to move said valves to their seats by their recoil when released from the action of the cam.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a compound gas-engine, the combination of two alternately-acting high-pressure cylinders each provided with a piston and an igniting-chamber; a single low-pressure cylinder provided with a piston and an igniting-chamber; means for alternately controlling the action of the valves communicating between said high-pressure cylinders and said low-pressure cylinder; means for leading the exhaust alternately from each of said high-pressure cylinders to said low-pressure cylinder; means for supplying one of said high-pressure cylinders with air and gas as the piston in the other high-pressure cylinder is being forced downwardly by the explosion therein; means for compressing the air and gas thus supplied in said high-pressure cylinders respectively with the downstroke of the piston in the low-pressure cylinder; means for manually changing the valve-operating mechanism so as to close the exhaust-passages between the two high-pressure cylinders and the low-pressure cylinder; means for automatically opening communication between the gas-supply and all three of said cylinders and means for automatically opening the exhaust from all of such cylinders into the atmosphere, whereby said engine may be used as a three-cylinder direct-acting engine, or as a compound engine, and whereby the air and gas are drawn into and compressed in the respective high-pressure cylinders by the action of the piston in the low-pressure cylinder, substantially as set forth.

2. In a gas or vapor engine the combination of two alternately-acting high-pressure cylinders each having a piston and furnished with an igniting-chamber, a low-pressure cylinder having an igniting-chamber and a piston, and taking the exhaust alternately from each of said high-pressure cylinders, a single electric battery and normally open circuit having sparking terminals in each of said igniting-chambers, means operated by the gas-controlling valve mechanism for closing the electric circuit with each of said sparking terminals in the high-pressure cylinders alternately at the end of the charge compression-stroke, means for manually changing the gas-controlling valve mechanism so as to admit gas to all of said cylinders alike, direct from the supply and cause them all alike to exhaust direct into the atmosphere, and means operated by the valve-controlling mechanism for closing the electric circuit with the sparking terminals in all of said igniting-chambers at the end of the charge compression-stroke in the several cylinders respectively, whereby said engine may be operated either as a compound or direct-acting engine at the will of the operator.

3. In a gas-engine the combination of two alternately-acting high-pressure cylinders, each having a piston and an igniting-chamber; a single low-pressure cylinder, having a piston and taking the exhaust alternately from each of said high-pressure cylinders; a single electric battery and normally open electric circuit, having sparking terminals in each of said igniting-chambers; means operated by the gas-controlling valve mechanism, for closing the electric circuit with the sparking terminals in the igniting-chambers of the high-pressure cylinders alternately at the end of the charge compression-strokes in said cylinders; two longitudinally-moving cam-shafts; a plurality of valve-actuating cams, supported from said shafts; a plurality of gas-controlling valves, supported by their respective valve-rods from said cams, the cams on the respective shafts being so adjusted as to control the passage of the gas both to and from the respective cylinder at the proper moment corresponding with the stroke of the pistons in such cylinders and means for simultaneously communicating a rotary motion to both of said shafts from the main crank-shaft of the engine substantially as set forth.

4. In a gas-engine the combination of two alternately-acting high-pressure cylinders each having a piston and an igniting-chamber; a single low-pressure cylinder, having a piston and taking the exhaust alternately from each of said high-pressure cylinders; a single electric battery and normally open electric circuit, having sparking terminals in each of said igniting-chambers; means operated by the gas-controlling valve mechanism for closing the electric circuit with the sparking terminals in the igniting-chambers of the high-pressure cylinders alternately at the end of the charge compression-stroke in said cylinders, two longitudinally-moving cam-shafts; a plurality of valve-actuating cams supported from said shafts, a plurality of gas-controlling valves supported by their respective valve-rods from said cams, the cams on the respective shafts being so adjusted as to control the passage of the gas both to and from the respective cylinders at the proper moment corresponding with the strokes of the piston in such cylinders; means for simultaneously communicating a rotary motion to both of said shafts from the main crank-shaft of the engine; means for simultaneously moving said cam-shafts longitudinally and means for reversing their operative relation to the gas-controlling valves substantially as and for the purpose specified.

5. In a gas-engine of the class described the

combination of high and low pressure cylinders, mechanism for reversing the valve-controlling cams and valves connected with said cylinders and converting said engine from either a single-acting to a compound or from a compound to a single-acting engine, an electric-circuit closure operated by the valve-actuating cam-shaft comprising a plurality of electrodes arranged in the line of movement of a revoluble circuit-closing arm, said arm and electrodes being in electric circuit with a battery and the sparking terminals of said several cylinders all substantially as and for the purpose specified.

In testimony whereof I affix my signature in the presence of two witnesses.

ALOIS LEINGARTNER.

Witnesses:

JAS. B. ERWIN,

F. SCHIFFENEDER.