No. 640,674. Patented Jan. 2, 1900.

G. W. LEWIS.

EXPLOSIVE ENGINE.

(Application filed Feb. 13, 1896. Renewed Sept. 22, 1898.)

(No Model.) 3 Sheets—Sheet 1.

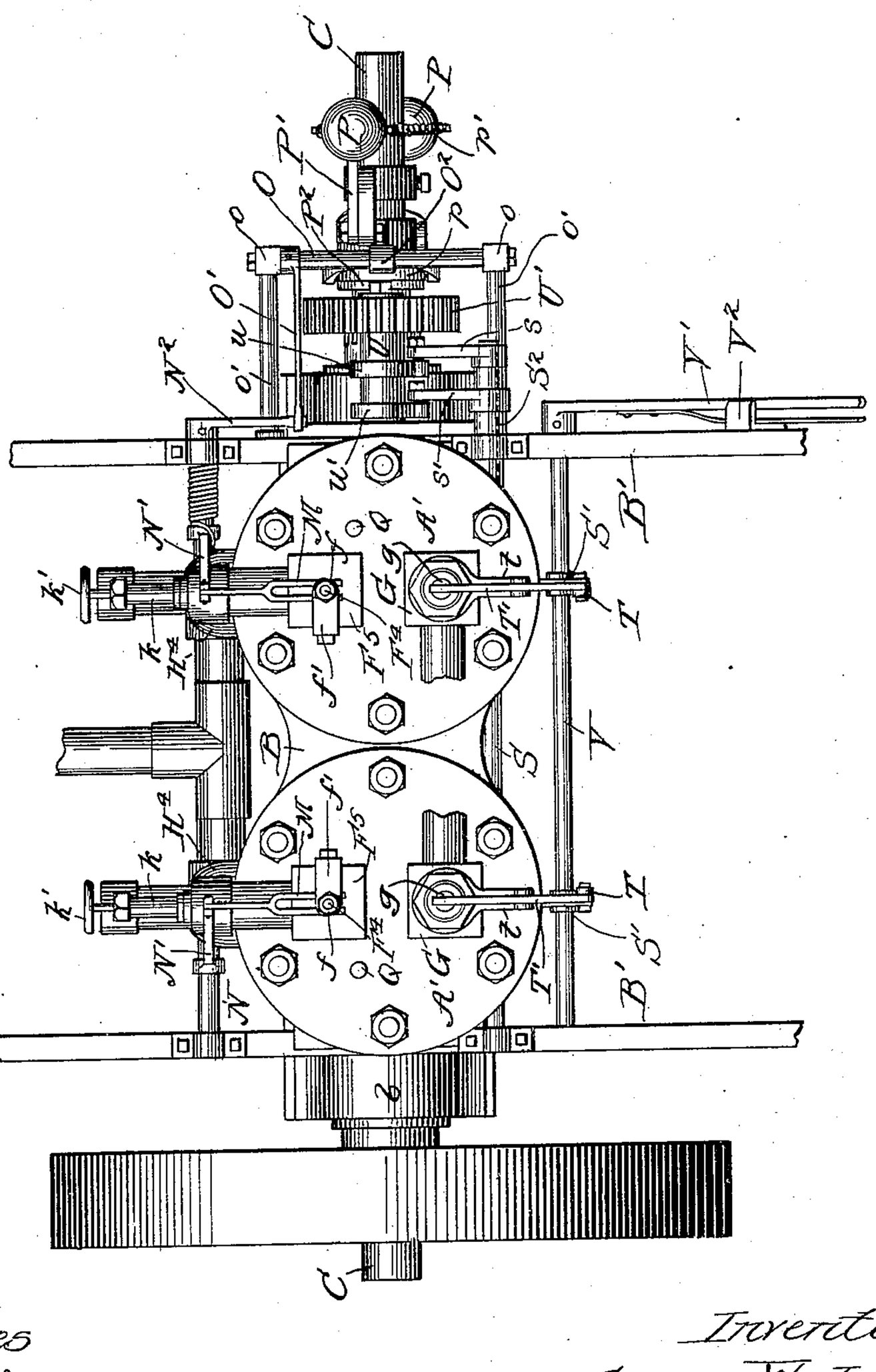

Fig. 1.

Witnesses
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(No Model.) 3 Sheets—Sheet 2.

Fig. 4.

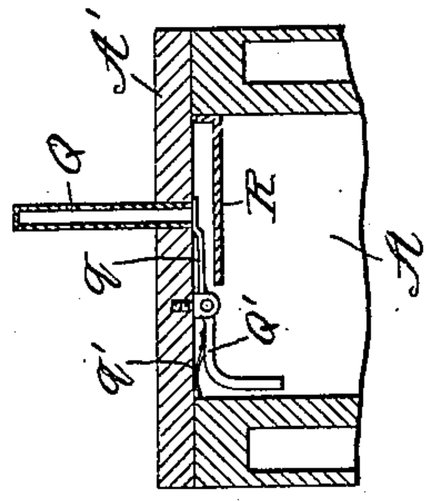
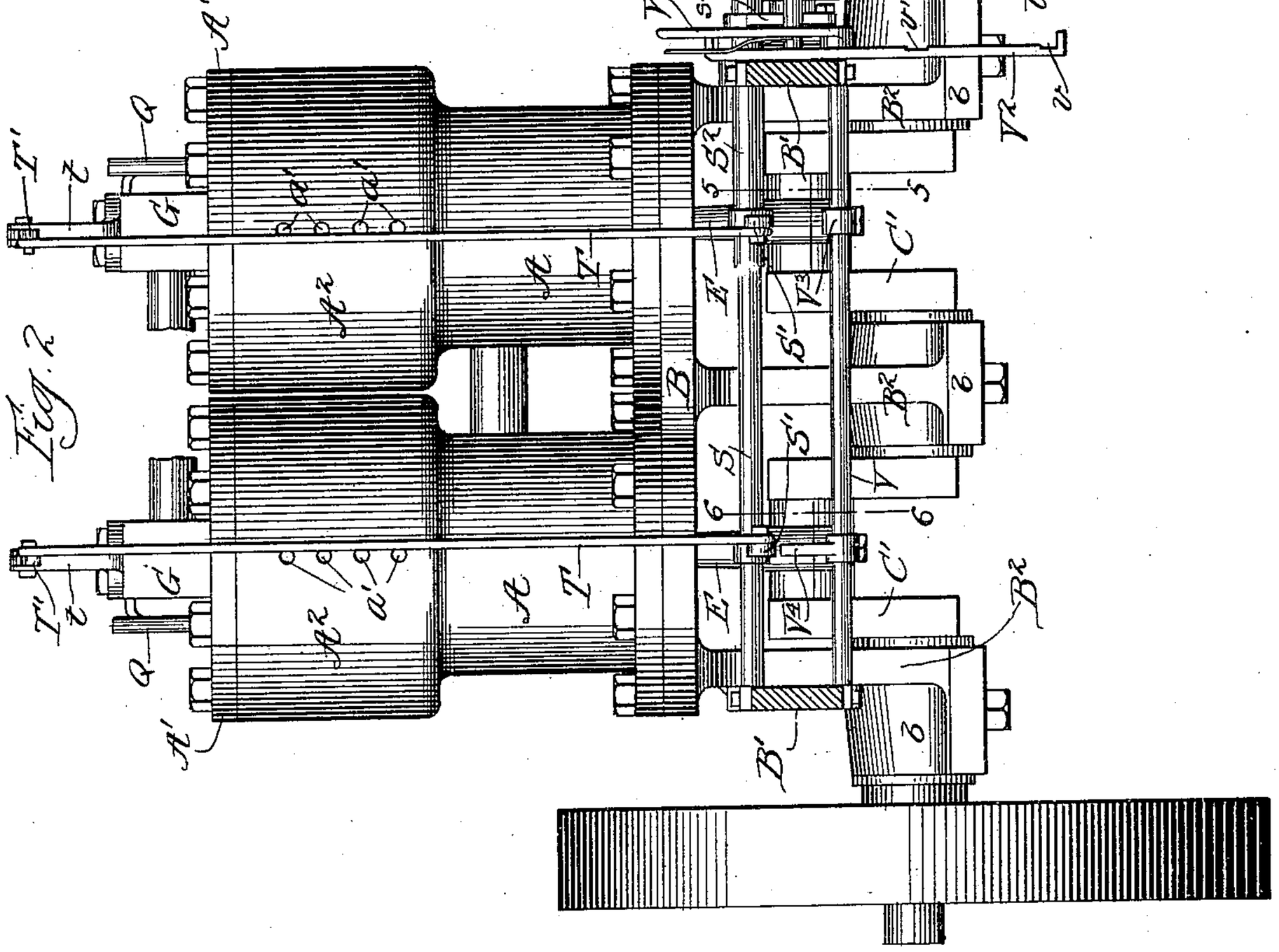


Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

Fig. 3.

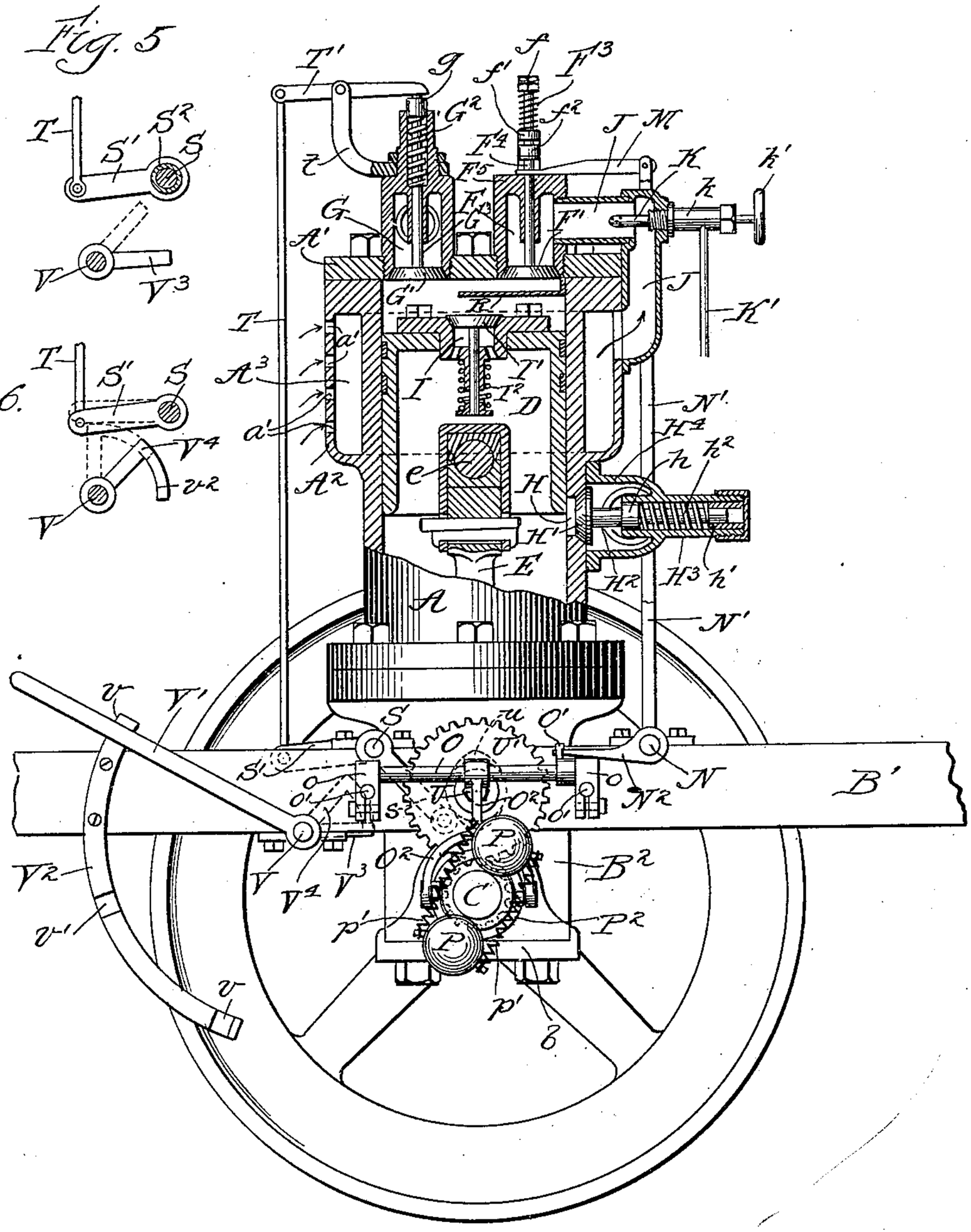

Fig. 5

Fig. 6.

Witnesses
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UNITED STATES PATENT OFFICE.

GEORGE W. LEWIS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE J: THOMPSON & SONS MANUFACTURING COMPANY, OF BELOIT, WISCONSIN.

EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 640,674, dated January 2, 1900.

Application filed February 13, 1896. Renewed September 22, 1898. Serial No. 691,630. (No model.)

To all whom it may concern:

Be it known that I, GEORGE W. LEWIS, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Explosive-Engines; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in gas-engines of that class known as the "Otto cycle" or those in which the explosion takes place at every second or alternate revolution of the crank-shaft and wherein the waste gases and products of combustion arising from the explosion of the charge are expelled in the back or inward stroke of the piston after each power-stroke and a new supply of the explosive mixture or charge is drawn into the cylinder in the outstroke preceding the power-stroke.

The invention relates more particularly to devices for use in connection with two-cylinder engines for opening and holding open the exhaust-valves at the time of starting the engine, whereby the same may be readily started by turning the crank-shaft by hand.

The invention consists in the matters hereinafter set forth, and more particularly pointed out in the appended claims.

In the accompanying drawings, Figure 1 is a plan view of an engine embodying my invention. Fig. 2 is a view in side elevation of said engine. Fig. 3 is an end elevation thereof with the cylinder and other operative parts in section. Fig. 4 is a detail section of the upper end of the cylinder, showing the ignition-tube. Fig. 5 is a detail section taken on line 5 5 of Fig. 2. Fig. 6 is a detail section taken on line 6 6 of Fig. 2.

As shown in said drawings, A A indicate the power-cylinders, which are in this instance arranged vertically and side by side and attached to a common frame or base-casting B, which is bolted to horizontal supporting-bars B′, which may represent the frame-bars of a vehicle. Said base-casting is provided with depending arms B^2 B^2, in which are formed bearings *b b b* for the crank-shaft C. Said shaft is provided with two cranks C′ C′ on the same side of the shaft and are arranged parallel with each other.

The cylinders A are opened at their lower ends and closed at their upper ends and contain pistons D D of hollow or trunk form, said pistons being connected with cranks C′ C′ by means of pitmen E, which are connected with the pistons by means of transverse bearing-pins *e*, affixed in the walls of the pistons and extending across to the hollow interior of the same in a familiar manner. With respect to their details of construction the two cylinders A A are alike, and in the following description of the parts immediately connected with the cylinders and their mode of operation one cylinder only will be referred to. Each cylinder A is provided with an inlet port or passage F and an exhaust port or passage G, (these being located in the head A′ of the cylinder,) an auxiliary exhaust-port H, located in position to be uncovered by the piston when the latter reaches the outer limit of its movement in its power-stroke, and a supplemental air-inlet port I, which in the instance shown is located in the piston D. The inlet-port F is provided with an inwardly-opening valve F′, having the form of a check-valve. Said valve is held usually in its closed position by a spring F^3 and is opened by atmospheric pressure acting against the tension of said spring to permit the inflow of air to the cylinder in the upstroke of the piston. An air pipe or passage J leads to said inlet-port for the admission of air thereto.

The means shown for supplying gas or vapor to the cylinder for making the explosive mixture consists of a supply-nozzle K, which enters the pipe J in the port F and is supplied with liquid hydrocarbon by means of the supply-pipe K′. The quantity of the liquid fed to the nozzle is controlled by a valve located in the casing *k* and operated by means of a hand-wheel *k*′.

The inlet-valve F′ is provided with a stem F^4, and the spring F^3, which is applied to hold the valve against its seat, is shown as located between a nut *f* on the upper end of the stem

and a stationary guide-bracket f', which is attached to the top of the casing and provided with a guide-aperture for the rod. Attached to such rod, below the bracket f', is a stop shoulder or collar f^2, which operates, in connection with a sliding wedge M, to variably limit the closing of the valve. An automatic governing device acts to move said wedge endwise, which governing device is made as follows:

N is a rock-shaft arranged at right angles to the axis of the cylinder and mounted on bearings in the frame-bars B' B', and N' is an upwardly-extending arm rigid with said shaft, to which is attached the outer end of the wedge M. Said wedge rests and slides on the casing F^5 and is slotted or forked at its inner end, so as to extend on opposite sides of the stem, which thereby forms a guide for the wedge to hold it from lateral displacement. The rock-shaft N is provided also with a rigid arm N^2, arranged at right angles to the arm N', and said arm N^2 engages a rigid arm O', attached to a rock-shaft O, Figs. 1 and 2, which latter rock-shaft is arranged adjacent to and transversely of the crank-shaft C. Said rock-shaft O has bearings in blocks *o*, attached to horizontal arms *o'*, secured in one of the frame-bars B'.

P P designate governor-weights on the crank-shaft, to which are attached bell-crank levers P', having arms parallel with the shaft to which the weights are attached and other arms transverse to the shaft, which engage an endwise-sliding sleeve P^2 on the crank-shaft. Said sleeve P^2 is connected with the rock-shaft O by means of an arm O^2 on the shaft, which is forked at its end adjacent to the sleeve P^2 and has inwardly-projecting pins engaging a ring *p*, which in turn is engaged with a groove in said collar. Coiled springs *p' p'* serve to yieldingly hold the governor-weights adjacent to the crank-shaft. The movement of the governor-weights is transmitted through the connections described to the sliding wedge M, which by being moved endwise serves as a movable stop to variably limit the opening of said valve.

The main exhaust-port is controlled by a valve G', which is held usually closed by a spring G^2 and is opened automatically at proper times by suitable operative connections with the crank-shaft. Said valve is provided with a stem G^3, having at its outer end a collar *g*, between which and the opposing surface of the exhaust port or passage is located the spring G^2. At the end of the cylinder adjacent to the crank-shaft C is located a rock-shaft S, having a rigid arm S', which is connected by means of a connecting-rod T with a lever T', which is pivoted centrally to a bracket *t*, secured to the head of the cylinder, and the free end of which acts upon the outer end of the valve-stem. Adjacent to and parallel with the crank-shaft C is located a counter-shaft U, which carries a gear-wheel U', which meshes with a gear-pinion U^2 on the crank-shaft, the gear pinion and wheel being of such relative size that the wheel will make one revolution during two revolutions of the crank-shaft.

u is a cam mounted on the counter-shaft U, and the periphery of which is engaged by the end of a rigid arm *s* on the rock-shaft. Said cam is provided at one side with a cam projection adapted to oscillate said rock-shaft S, and thereby open the exhaust-valves once at every revolution of the cam.

The rock-shaft S, hereinbefore referred to, serves for one of the cylinders only, that being the one remote from the end of the shaft at which the actuating devices are located. Another rock-shaft S^2, tubular in form and surrounding the shaft S, is employed to give motion to the exhaust-valve of the cylinder nearest said actuating devices. The end of the rock-shaft S adjacent to said actuating devices projects through the tubular shaft S^2 and has upon it the rigid arm *s* referred to. Attached to the rock-shaft S^2 is a second crank-arm *s'*, the free end of which is engaged by a second cam *u'*, which is diametrically opposite to the cam *u*. The tubular rock-shaft S^2 is shown as having suitable bearing in a frame-piece B' nearest the actuating devices, while the same end of the rock-shaft S is supported and has engagement with the tubular rock-shaft only. At its opposite end said rock-shaft S is engaged with a bearing on the other frame-piece B', as shown in Fig. 1.

The means for opening and holding open the exhaust-valves and which constitutes the present invention are made as follows:

V is a rock-shaft arranged parallel with the rock-shaft S and below the arms S' of said rock-shaft. Said rock-shaft V is provided with a hand-lever V', which moves along a stop-segment V^2, having end notches *v v* and an intermediate notch *v'*, which latter is adapted to engage the hand-lever at the middle point of its stroke. Attached to said rock-shaft V at points opposite the arms S' S' are two rigid actuating or cam arms V^3 V^4, of which the arm V^4 has a segmental extension v^2, the outer edge of which is curved concentrically with the axis of the shaft. Said cam-arms V^3 V^4 are adapted to act upon the lever-arms S', so as to lift the same, and thereby open the exhaust-valves when the rock-shaft is actuated through the medium of the hand-lever. Said cam-arms, however, are not arranged to operate at the same time, but are disposed in angular relation to each other on the shaft, as shown in dotted lines in Fig. 3 and in full lines in Figs. 5 and 6, and the angular relation of the arms is such that the arm V^4 will act to open the exhaust-valve of the cylinder adjacent to it before the arm V^3 reaches the crank-arm S'. Moreover, the parts are so arranged that the arm V^4 will operate to fully open the exhaust-valve when the hand-lever has made a half stroke or reached

the middle point of its movement, while a completion of the movement of the hand-lever and further movement of the rock-shaft is required for bringing the arm V^3 into operation. The curved projection v^2 of the cam-arm V^4 serves to maintain the valve which it operates open during such further movement of the shaft as is required to bring the second arm V^3 into operation. The purpose of this construction is to enable one only of the exhaust-valves to be opened, if desired, in starting the engine, it being obvious that if the engine be started by the use of one cylinder alone the necessary compression of the charge in the second cylinder will be given by the power of the first cylinder. It follows that the engine may be easily started by turning the hand-lever through half of its stroke, and thereby opening the exhaust-valve of one of the cylinders; but if it be desired to admit the explosive charge to both cylinders at once in starting the engine then the full stroke may be given to the hand-lever, in which case both exhaust-ports will be opened, with the result of relieving the pressure to a desired extent in the cylinders, and thus enabling the crank-shaft to be turned by hand to give compression of the charges necessary for the initial explosion in both of said cylinders.

The exhaust-port H is supplied with a valve H′, attached to a valve-stem H^2, which is provided with a collar h, between which and an opposing shoulder h', formed in the tubular sleeve or projection H^3, is located a coiled expansion-spring h^2, which tends to hold the valve against the seat. Said valve is located in the casing H^4, to which is connected a pipe leading to a suitable point of delivery for the exhaust or waste gases.

The supplemental air-inlet passage is provided with a spring-actuated check-valve I′, adapted to open inwardly or toward the interior of the cylinder, so that in the outer movement of the piston if the main inlet-port F be not open sufficiently to fill the cylinder with air as fast as required by the speed of the engine said check-valve will open and permit the inflow of an additional amount of air through the same. For this purpose the spring I^2 of the said check-valve is made stronger than the spring of the main inlet-valve F′, so that the latter will open before the pressure is great enough to open the check-valve.

The igniting device herein shown consists of an ignition-tube Q, Fig. 4, which extends through the cylinder-head, is open at its inner end, and is closed at its outer end in the usual manner. The inner end of this tube, as shown in Fig. 4, is held normally closed by means of an oscillating valve-plate q, attached to a lever Q′, which is held by a spring q' in position to retain the valve-plate q in contact with the inner end of the ignition-tube. Said lever Q′ is provided with an inwardly-projecting end adapted for contact with the piston, arranged in such position that the lever will be actuated and the valve-plate moved to open the ignition-tube at the inner limit of the movement of the piston.

A plate or partition R is arranged within the cylinder, adjacent to the head thereof and parallel with the cylinder-head, in a manner to form a partial inclosure or chamber adjacent to the inlet-port and the inner end of the ignition-tube. Said partition serves to confine the explosive mixture which enters the inlet-port in the part of the cylinder adjacent to the igniting devices, and thus insures ignition at the proper time without regard to the quantity of air which may enter through the supplemental port.

The upper end of the cylinder A is surrounded by a jacket A^2, which forms an annular chamber A^3, which is in communication at one side of the cylinder with the surrounding air through suitable inlet-openings a' a'. At its opposite side said chamber communicates with the inlet or admission port of the cylinder by means of the air pipe or passage J, which is in this case extended to connect with the jacket A^2. The said chamber A^3 forms in this construction a part of the air-supply passage leading to the inlet-port F, so that air drawn into the cylinder for making the explosive mixture or charge is carried around or over the wall of the cylinder, and thus serves the purpose of the water-jacket heretofore commonly employed for maintaining a suitably-low temperature in the cylinder.

The novel features of the valve mechanism and the arrangement of the inlet and exhaust ports are not herein claimed, but are made the subject of a separate application, which has been divided from the present application and was executed by me on the 1st day of June, 1899.

I claim as my invention—

1. The combination with two engine-cylinders, and a single crank-shaft provided with two cranks standing at the same side of the shaft, of exhaust-valves on both cylinders and means for operating both of said exhaust-valves, comprising a hand-actuated rock-shaft, having two actuating-arms disposed at different angular positions, whereby one or both of said valves may be thrown out of action.

2. The combination with two engine-cylinders, and a crank-shaft having two cranks arranged at the same side of the shaft, of exhaust-valves on the cylinders, two rock-shafts provided with rigid arms which are connected with and actuate the exhaust-valves, and a hand-actuated rock-shaft provided with two rigid arms arranged to act on the arms of the first rock-shafts, said arms on the hand-actuated rock-shaft being arranged at different angles, whereby one or both of the valves may be thrown out of action.

3. The combination with two engine-cylinders, each provided with an exhaust-valve, of means for opening and holding open the ex-

haust-valves, comprising a hand-actuated rock-shaft provided with two actuating-arms disposed at angular positions and one which is provided with a lateral extension forming a curved bearing-surface.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 4th day of February, A. D. 1896.

GEORGE W. LEWIS.

Witnesses:
C. CLARENCE POOLE,
WILLIAM L. HALL.