(No Model.) 4 Sheets—Sheet 1.

G. W. LEWIS.

GAS ENGINE.

No. 571,534. Patented Nov. 17, 1896.

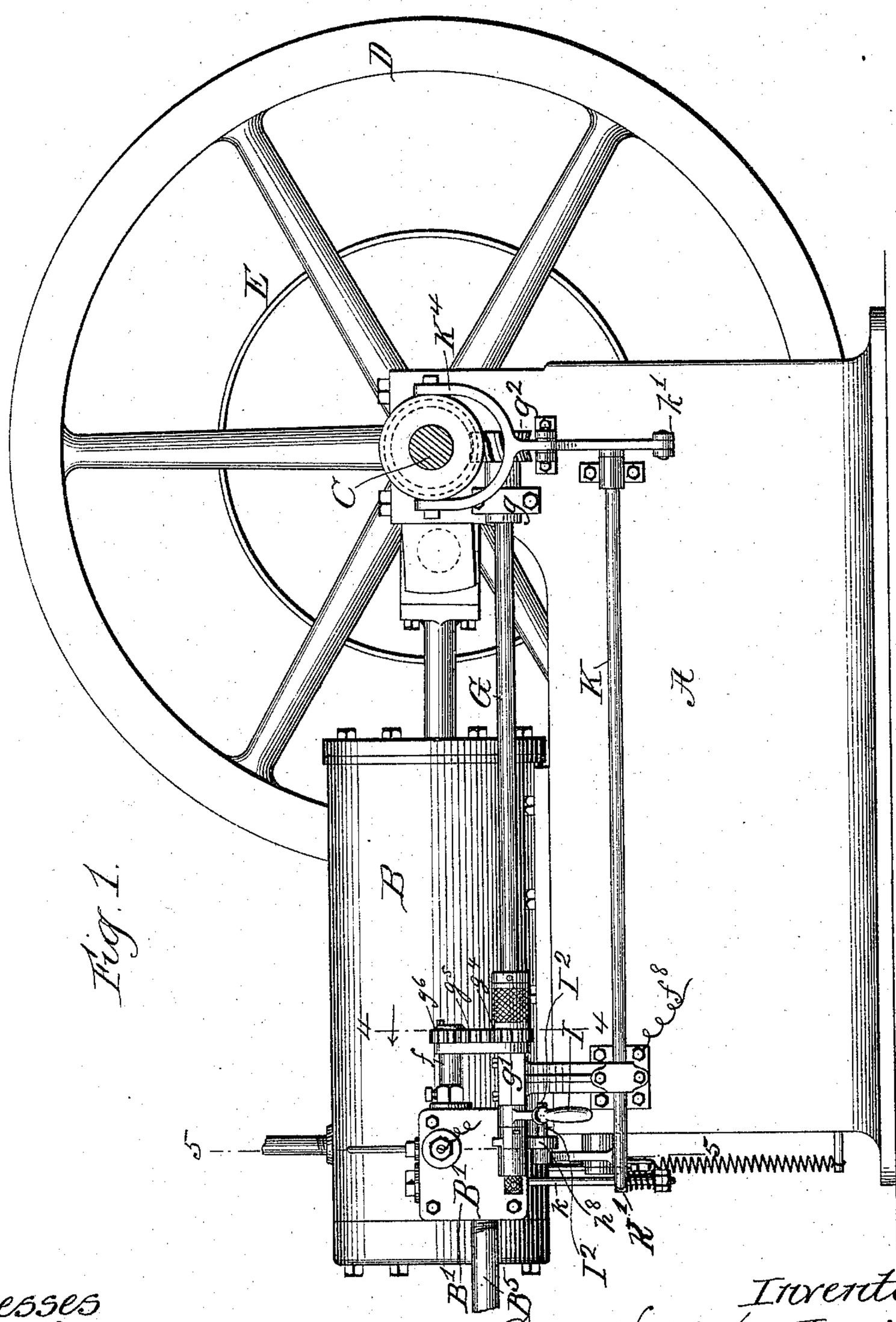

Fig. 1.

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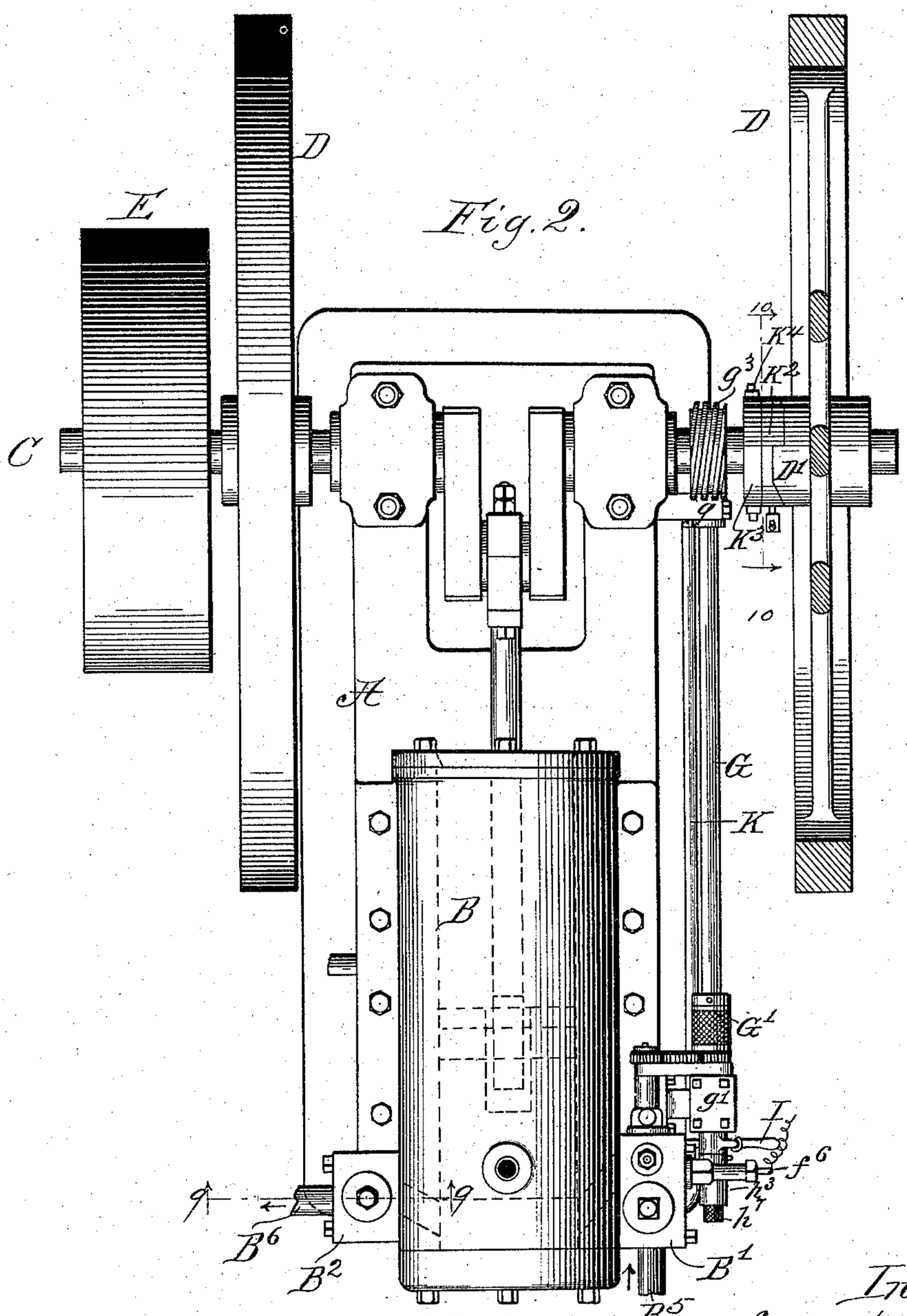
Fig. 2.



Witnesses:
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4 Sheets—Sheet 3.

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Fig. 3.

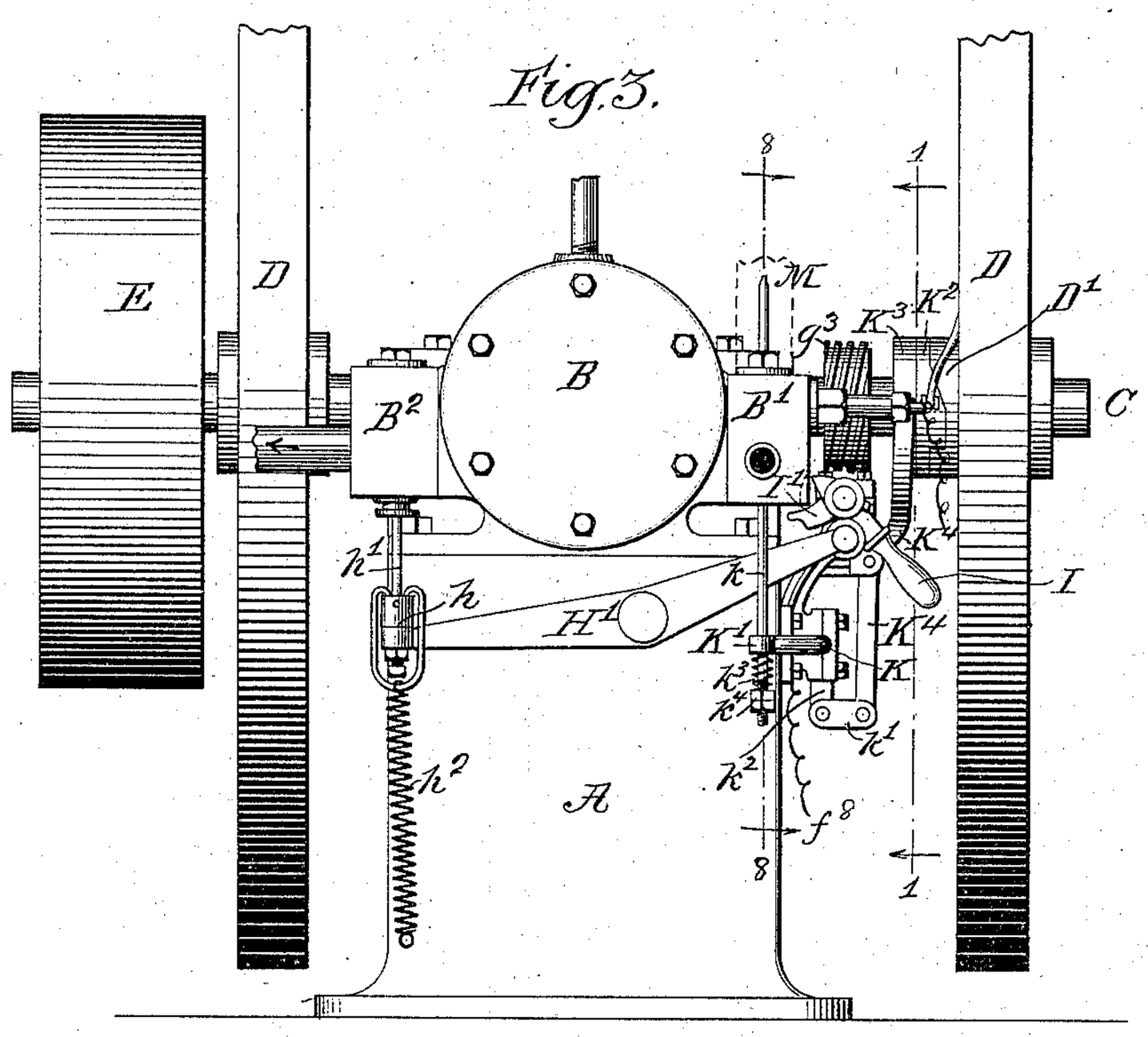


Fig. 4.

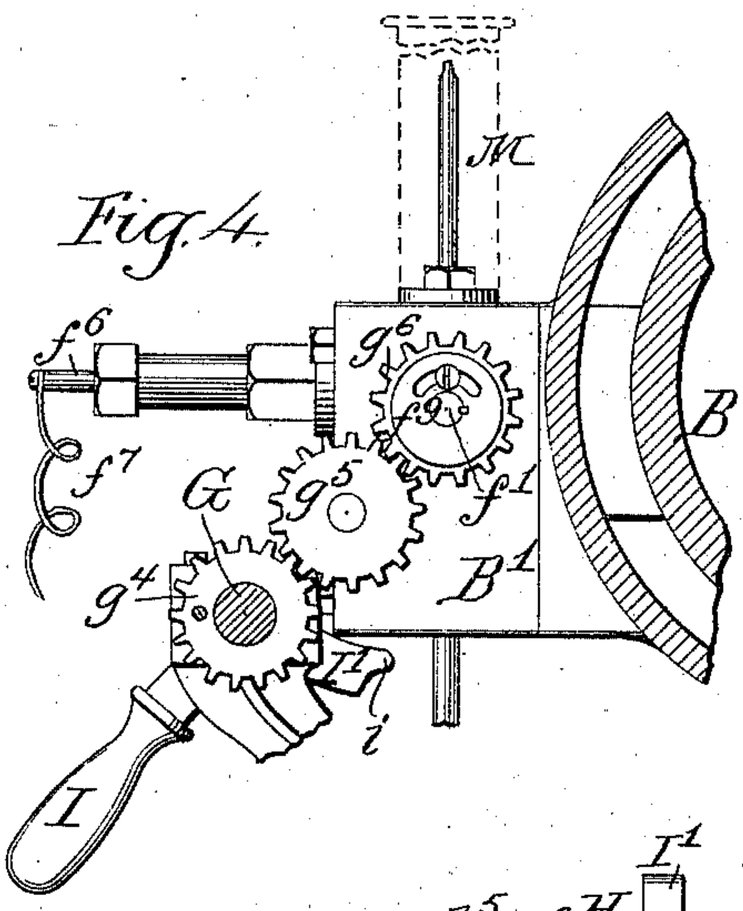


Fig. 5.

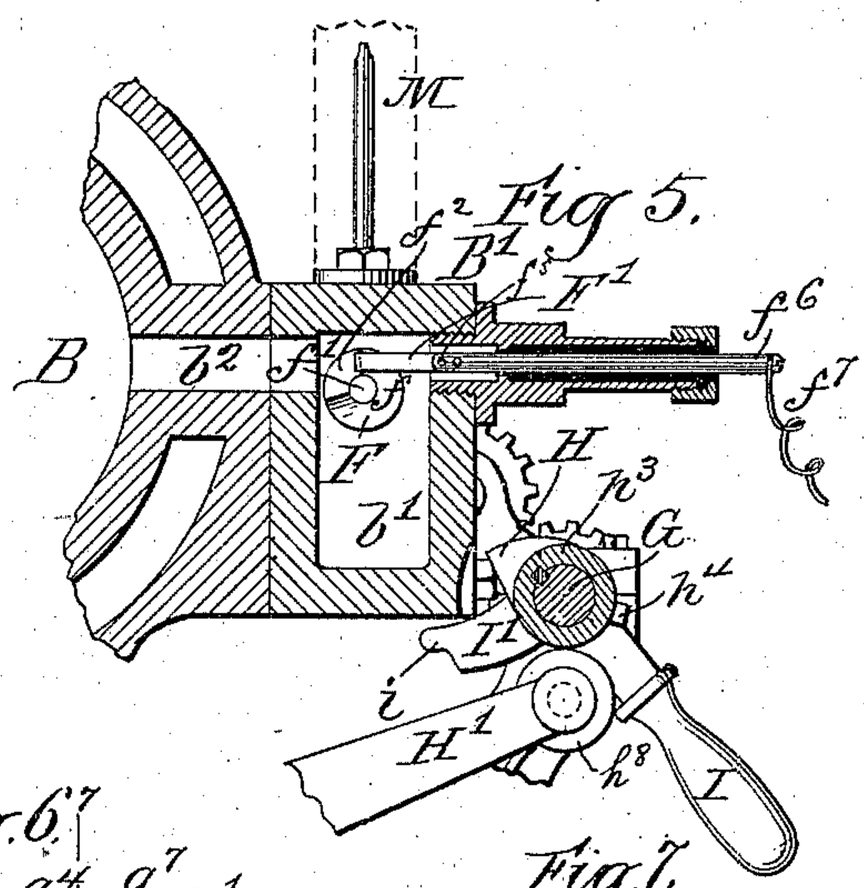


Fig. 6.

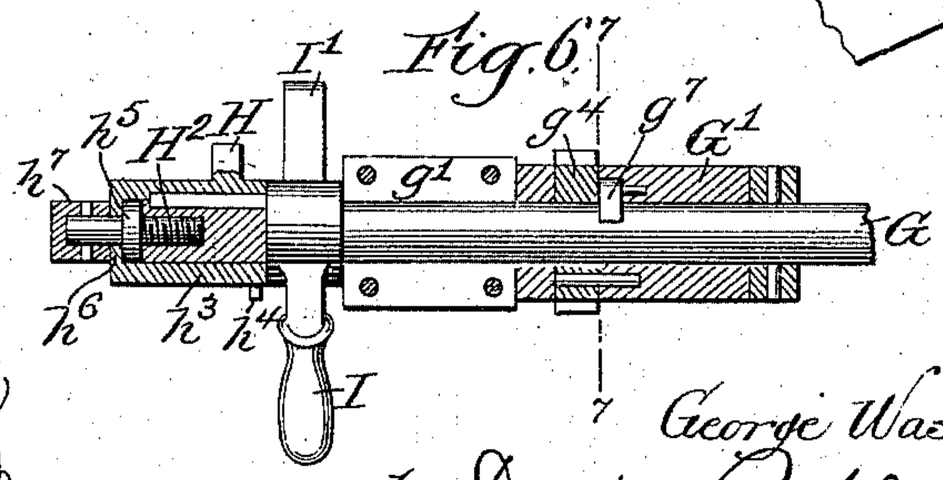
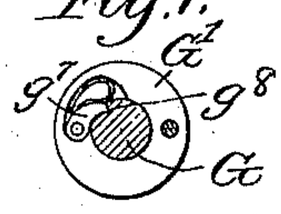


Fig. 7.



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(No Model.) 4 Sheets—Sheet 4.

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Fig. 8.

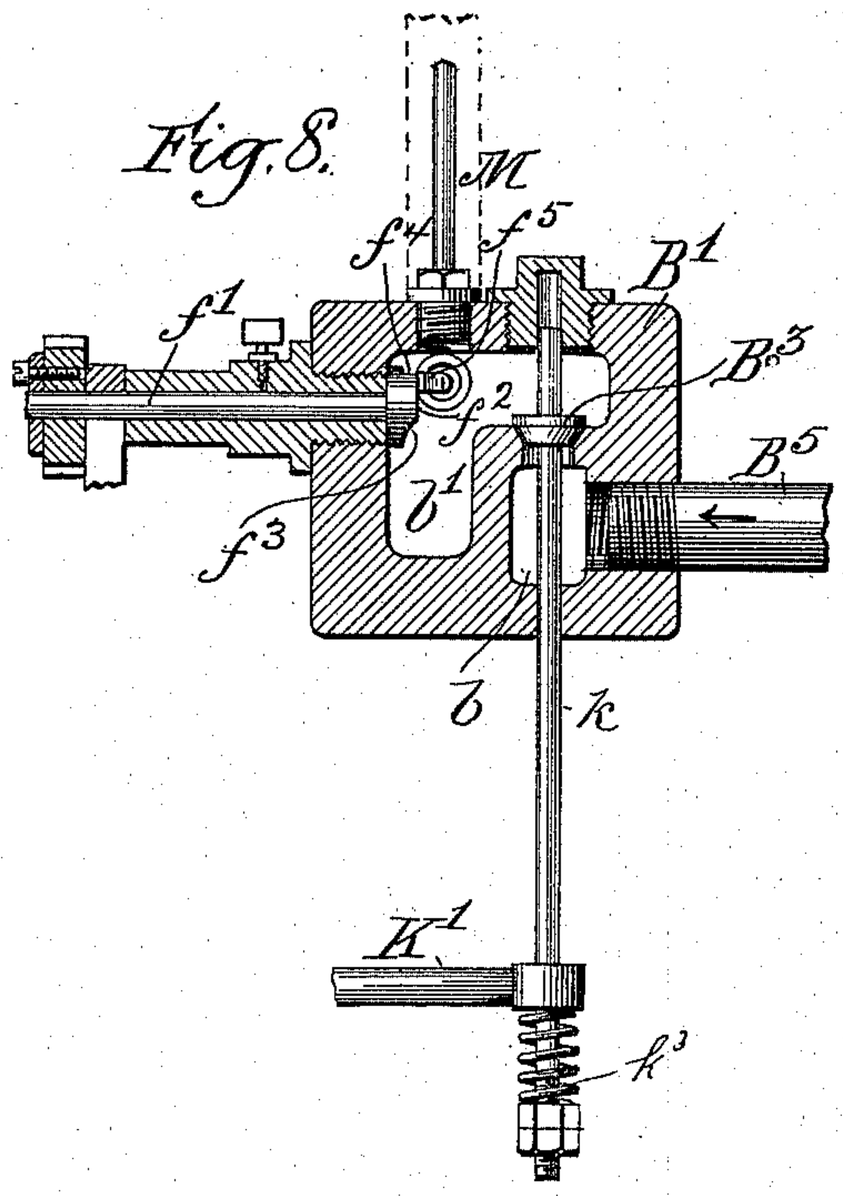


Fig. 9.

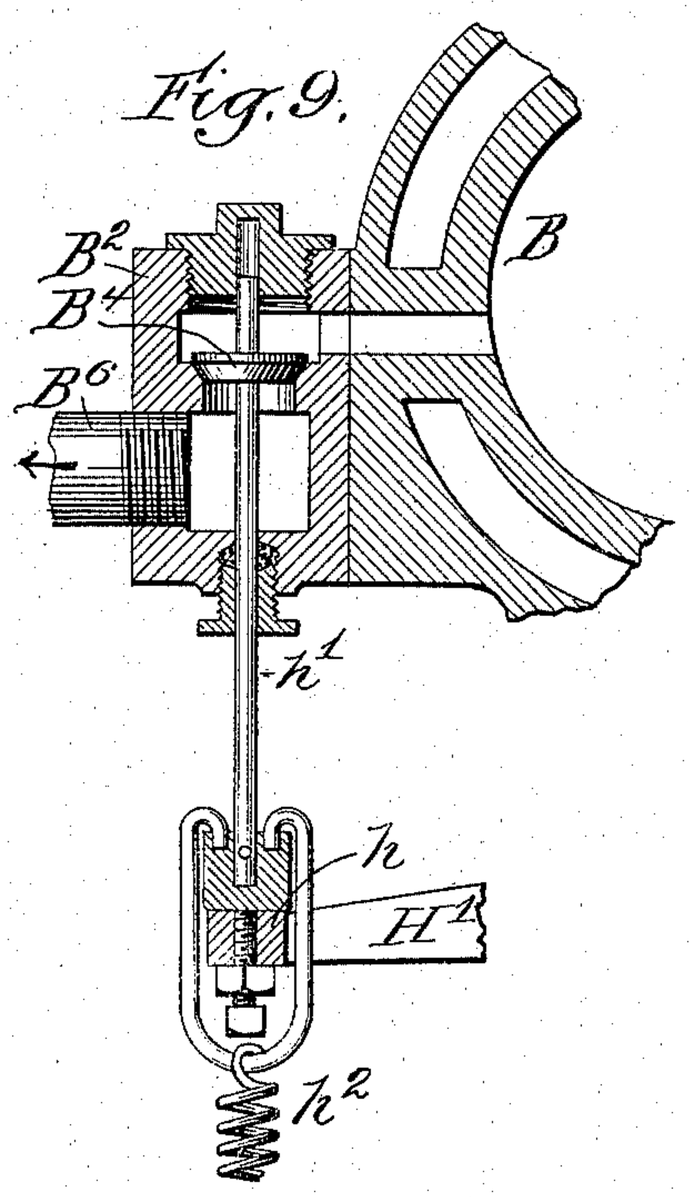


Fig. 10.

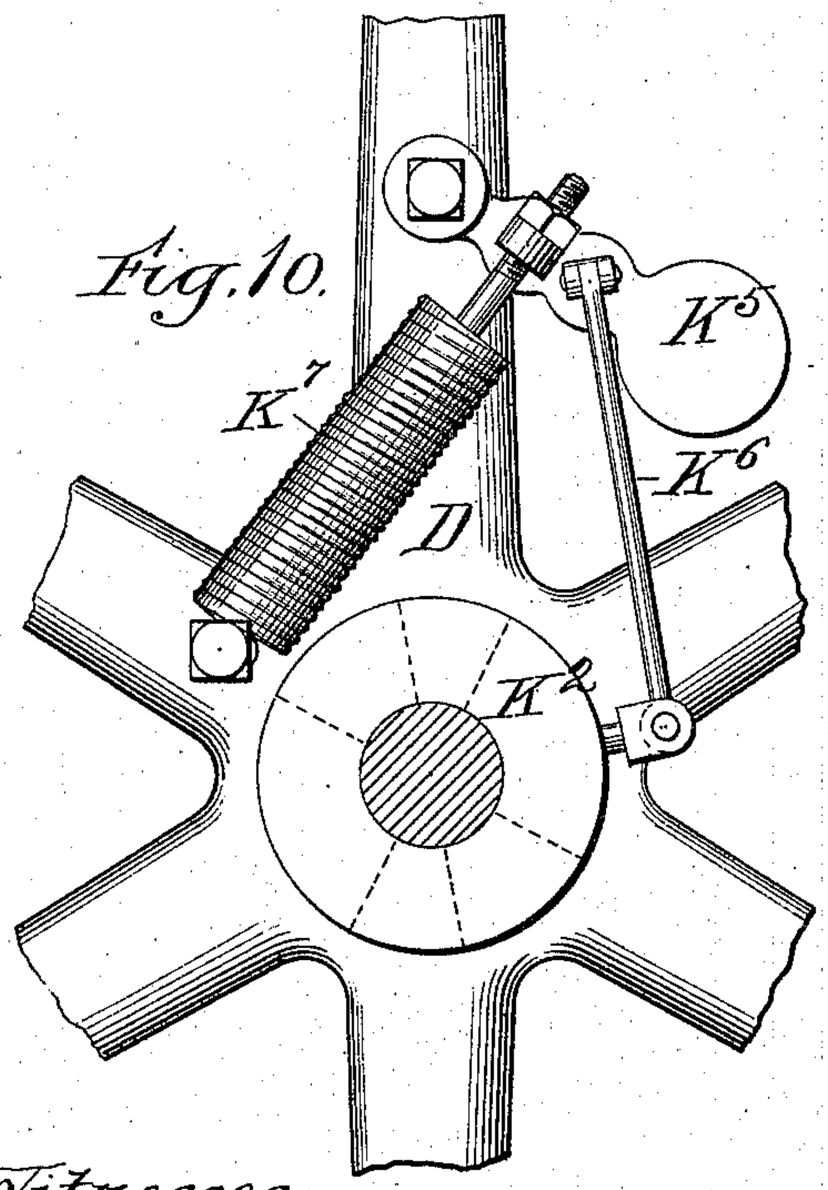
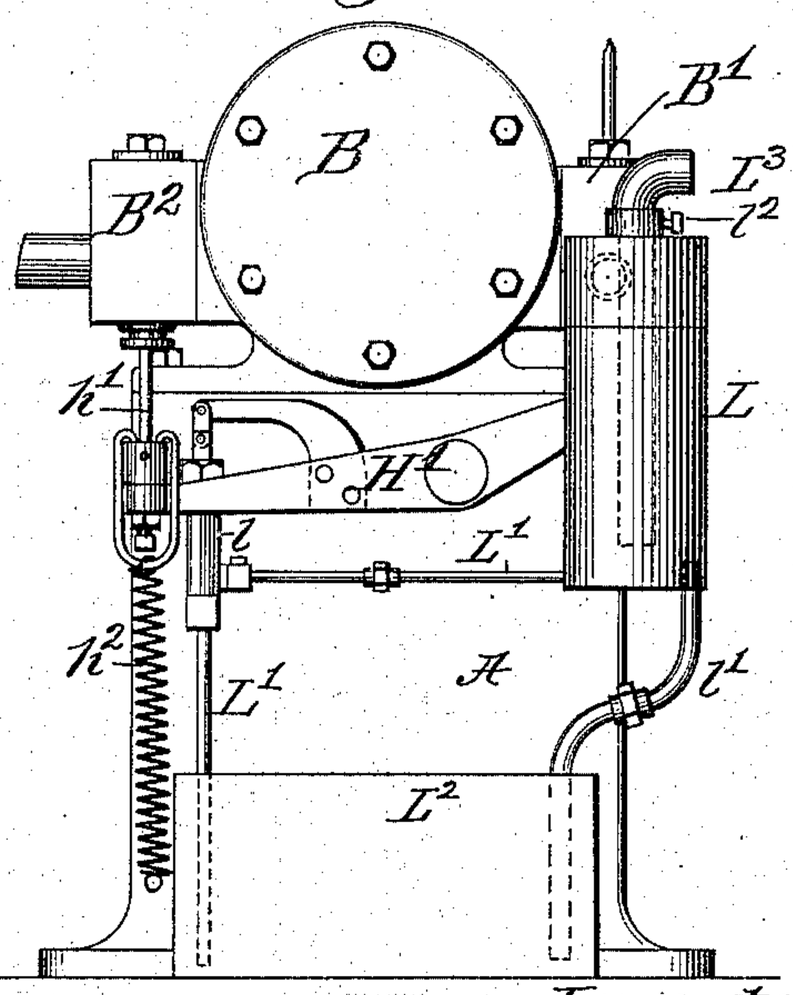


Fig. 11.



Witnesses
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UNITED STATES PATENT OFFICE.

GEORGE W. LEWIS, OF CHICAGO, ILLINOIS.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 571,534, dated November 17, 1896.

Application filed August 4, 1893. Serial No. 482,343. (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 Gas-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.

The improvements herein described and claimed relate in part to speed-governing devices and in part to electric igniting devices.

The first of said improvements has for its object to provide a practical construction and method by which an explosion may be made at each alternate stroke of the piston instead of sometimes at longer intervals and whereby greater steadiness in the operation of the engine and in the application of its power are attained.

The second of said improvements has for its primary object to provide an improved electric-spark-producing mechanism which may be conveniently operated by hand and at will to facilitate the starting of the larger sizes of engines without the application of manual force to the crank-shaft.

The nature of these improvements will be made plain by the following description of the accompanying drawings, which illustrate one practical embodiment thereof, and the appended claims define the improvements as thus or otherwise embodied.

In said accompanying drawings, Figure 1 is mainly a side elevation of a gas-engine containing the improvements relating to the igniting and governing devices, the section of the crank-shaft being taken on line 1 1 of Fig. 3. Fig. 2 is a top or plan view of the construction shown in Fig. 1. Fig. 3 is an end view of the same. Fig. 4 is a detail view, enlarged, in vertical section of line 4 4 of Fig. 1. Fig. 5 is a similarly-enlarged detail view in the section-line 5 5 of Fig. 1. Fig. 6 is an enlarged horizontal section of certain parts applied to the rotating exhaust-operating shaft, taken in the plane of the meeting faces of the rear bearing, which supports said shaft. Fig. 7 is a vertical section of said shaft on the same scale and in the line 7 7 of Fig. 6, showing certain adjacent parts in side elevation. Fig. 8 is an enlarged vertical section of the feed and ignition chest in the plane of line 8 8 of Fig. 3. Fig. 9 is an enlarged vertical section of the exhaust-valve chest in the plane of line 9 9 of Fig. 2. Fig. 10 is an enlarged section in the line 10 10 of Fig. 2, looking toward the adjacent fly-wheel. Fig. 11 is an end view showing the vaporizing devices preferably employed when hydrocarbon vapor is used instead of gas to make the inflammable mixture by explosion of which the machine is propelled.

The same designating-letters are applied to the same parts in all figures of the drawings.

A indicates the frame or bed of the machine; B, the piston-cylinder; C, the crank-shaft; D D, fly-wheels, and E a belt-pulley on said shaft. The cylinder B is provided with two chests B′ and B^2, arranged on opposite sides of the closed end of said cylinder, as best seen in Figs. 2 and 3, the former, B′, containing the supply-valve B^3, together with the electrodes of the ignition mechanism, and the latter, B^2, containing the exhaust-valve B^4 in the part leading from the cylinder B.

B^5 is a supply-pipe for gas or vapor and air leading to the chest B′ from a suitable mixing-chamber or other source of supply, and B^6 is an exhaust-pipe leading from the chest B^2 to any suitable point of discharge.

The supply-valve chest B′ has two chambers *b b′*, Fig. 8, the latter of which communicates with the interior of the power-cylinder B through a suitable passage b^2, Fig. 5, and the former of which receives the supply-pipe B^5, as shown in Fig. 8.

The electrodes of an electric ignition mechanism are shown in Figs. 5 and 8 as being present in the chamber *b′*, and they consist of the rotary cam-shaped electrode F and the non-rotative electrode F′. The former, F, consists of a head *f*, carried within the chamber *b′* on a rotating shaft *f′*, which extends out of said chamber to communicate with its driving devices. Said head *f* has a prominence f^2 on its circular face, which prominence has an inclined side f^3 and an abrupt side f^4. The electrode F′ to coöperate with this form of the electrode F consists of a

spring f^5, arranged at right angles to the axis of F and adapted to yield as it is pressed by the inclined side of the rotating electrode F, to be held in tension while the prominence f^2 passes in contact therewith, and to be suddenly relaxed as it passes off said prominence at the abrupt shoulder f^4 of the latter. The igniting-spark is emitted upon this termination of contact, and the break of connection is timed to follow the compression of a charge of gas or vapor and air within the cylinder B and at the commencement of the following outstroke of the piston within said cylinder. The spring-electrode F′ is shown supported upon an adjustable metallic bar f^6, which is screw-threaded and passes out of the chamber b' through an insulating-body of closely-compressed asbestos or equivalent material with which its screw-threaded surface engages and affords at its outer end the necessary connection with a current-wire f^7. In addition to performing its function as an electrode the spring f^5, by its pressure on the outer face of the head f, serves to force the rear face of the latter tightly against the adjacent inner surface of the chamber B′, thus forming a seal between the chamber and the journal-aperture through which the shaft f' passes, by reason of which I am enabled to dispense with any form of stuffing-box or packing around said shaft, and whereby the erosive action of the exploding gas or vapor on the journal-bearing is prevented. The opposite current-wire f^8, Figs. 1 and 3, may be connected with any part of the machine in metallic connection with the electrode F. For the timely rotation of said electrode F the following devices are shown:

G is a shaft mounted in bearings g g' at the side of the machine and provided with a worm-wheel g^2, which is engaged with a worm g^3 on the crank-shaft. This shaft G also carries a pinion g^4, which, through an idle-pinion g^5, drives a pinion g^6 on the outer end of the electrode-shaft f'. The connection of the pinion g^6 with the shaft f' is made adjustable through the medium of a segmentally-slotted plate f^9, secured to said shaft and fastened to the pinion by a clamp-screw passing through the slot, as indicated in Fig. 4, and by this means the time of producing the igniting-spark may be nicely adjusted with respect to the position of the piston within the cylinder B.

For the purpose of permitting manipulation of the rotating electrode F independently of the movement of the crank-shaft and shaft G (as, for example, in starting a larger size of the engine) the initial pinion g^4 is made loose on the shaft G and is secured to a sleeve G′, which is also loose on said shaft and which carries a spring-pawl g^7, arranged to engage a single notch g^8 in the periphery of said shaft, as indicated in Figs. 6 and 7. This sleeve has a milled surface, as shown, or is otherwise adapted to be turned by hand, so that after a charge of the explosive mixture has been pumped into the cylinder behind the piston, by any of the usual or other suitable devices, (not shown,) the electrode F may be rotated by hand and an explosion produced to start the crank-shaft. Upon the rotation of said shaft and its connected shaft G and release of the sleeve from the hand the shoulder on the shaft G engages the pawl in said sleeve and puts the pinion-gear and rotary electrode in regular and timely motion.

The worm-gear is shown as being adapted to give one rotation of the shaft G for two of the crank-shaft, for the purpose of giving ignition for every alternate stroke of the piston and for also giving exhaust of the contents of the cylinder on every alternate stroke, as will presently be described, the exhaust being also controlled by said shaft.

For the control of the exhaust-valve B^4 in the regular operation of the engine the shaft G carries the cam H, which strikes downwardly upon one end of the centrally-pivoted lever H′, that in turn bears upwardly at its opposite end against a shoulder h on the downwardly-directed valve-stem h' of the valve B^4, a spring h^2 being connected to said valve-stem to return the valve promptly to its seat. The cam H is carried by the shaft G through the medium of a splined and lengthwise-movable sleeve h^3, as best shown in Fig. 6. The sleeve h^3 also carries a short cam projection h^4 opposite the cam H and a little out of the central plane of the latter, the said shorter cam passing in the regular operation of the engine clear of the lever H′, but being adapted to be brought into position to encounter said lever by the lengthwise movement of the sleeve h^3. It is the object of this shorter cam projection h^4 to discharge about half the charge within the cylinder preliminary to the full compression of the remaining portion of said charge in the starting of the engine and to prevent the arrest of the crank-shaft by reason of insufficient momentum in the fly-wheels to compress a full charge. To bring the shorter cam into action with the lever H′, I have provided a screw H^2, threaded axially into the adjacent end of the shaft G and provided with a collar h^5, which is arranged to bear outwardly against an inturned flange h^6 on the outer extremity of the sleeve h^3. The protruding end of the screw H^2 is provided with a milled head or other similar device h^7, by which it may be seized and turned by hand or held from rotation while the shaft G rotates. Retraction of the screw H^2 obviously slides the sleeve h^3 and its cam outwardly with respect to the shaft G, when said shaft is not in motion, and the holding of said screw from rotation while the shaft G rotates serves to run the screw into the shaft and to slide the sleeve backwardly upon the shaft G.

In addition to the cams described for operating the exhaust-lever H′ the shaft G has further mounted thereon a loose hand-lever I, which is provided at its inner end with an arm I′, having a stop projection i upon the

upper part of its free extremity. The lever H′ is also provided with a projection I^2, (which in this case also serves as the axis-pin for the support of a friction-roller h^8,) against which the arm I′ of the hand-lever I strikes. By raising the outer arm of said hand-lever I the arm I′ of said lever depresses the adjacent end of the valve-lever H′, and such depression of said lever may be carried far enough to bring the pin or projection I^2 over the end of the arm I′ of the hand-lever and against the stop projection thereon, in which position of the hand-lever the valve-lever H′ is locked and the valve B^4 is held raised from its seat. This hand-lever serves the obvious purpose of allowing the crank-shaft to be rotated by hand without compression of fluid behind the piston actuated thereby and a desired speed and momentum of the fly-wheels to be obtained preliminary to imposing any resistance of compression upon the piston in starting the engine. This device is therefore especially adapted to facilitate the starting of the smaller sizes of the engine and to accomplish the same useful result in starting the medium and larger sizes when initial motion is given by force applied to the fly-wheels and preliminary to the use of the half-stroke exhaust devices already described in such sizes or under such circumstances as require the use of the latter in connection with the hand-lever.

The speed-governor mechanism, as illustrated, comprises a rock-shaft K, having a lateral arm K′ projecting beneath the supply-valve B^3 to engage the stem k of said valve, (see Figs. 1, 3, and 8;) a cam K^2 on the crank-shaft, coöperating with the cam-surface on the contiguous face of the hub D′ of the adjacent fly-wheel D; a loose collar K^3 on the crank-shaft, acted upon by the cam K^2; a yoke-lever K^4, communicating motion from the collar K^3 to the rock-shaft K, and a centrifugal governor-weight K^5, mounted on the fly-wheel and connected with the cam K^2 through a link K^6, and a spring K^7, arranged to oppose the centrifugal action of said weight. The yoke-lever K^4 is connected by a link k' with a vertical arm k^2 on the adjacent end of the rock-shaft K, and a cushioned spring k^3 is inserted between the apertured end of the arm K′ and the adjustable nut or shoulder k^4 on the valve-stem k. In this construction of the governing devices the arm K′ of the rock-shaft K limits the height to which the inlet-valve B^3 may be raised by suction produced in the outstroke of the piston within the cylinder B, and consequently regulates the quantity of explosive fluid taken into the cylinder in such outstroke of the piston. The fluid thus admitted is of substantially uniform quality as to the proportions of gas or vapor and air, and it is exploded at each active stroke, which is each alternate stroke of the engine, and the force of the explosion is varied according to the quantity of such fluid so exploded. By this means an exceedingly uniform speed of the engine is obtained, which is of the utmost importance in all classes of work to which the engine may be applied, but is especially important in the production of incandescent electric lighting, in which it is found that the light produced is of substantially perfect uniformity. The spring k^3 is not absolutely indispensable, but, serving as a cushion between the shoulder or nut k^4 on the valve-stem k and the arm K′ on the rock-shaft, it contributes to the uniformity of action just explained and prevents noise of the otherwise contacting parts.

L, Fig. 11, represents a hydrocarbon vaporizer or carbureter which may be employed when hydrocarbon vapor is to be used instead of gas to form an explosive mixture with air. In this vaporizer a practically constant level of the liquid to be vaporized is preserved by the provision of an inlet-pipe L′, leading from a low tank L^2, through a pump l, or from an elevated tank, as preferred, and an outlet-pipe l', the open mouth of which stands at a desired height within the carbureter vessel L. The top of said vessel L is closed, and the upper part of its interior communicates with the supply-pipe B^5 of the engine. Through the top of the vessel L enters an air-supply tube L^3, which is vertically adjustable, and the open lower end of which may therefore be made to approach or recede from the surface of the liquid at pleasure, a set-screw l^2 serving to hold the air-tube L^3 at any selected position. This construction is substantially that set forth in my allowed application for patent, Serial No. 384,876, and has the mode of operation and the advantages therein stated.

The inflow of air into the carbureter L is induced by the suction of the engine in operation, and the violence of the inflowing air upon the surface of the liquid varies inversely with the distance of the mouth of the inflow-tube from the surface of the liquid. If the liquid have low volatility therefore, the mouth of the tube L^3 will be set nearer to the surface of the liquid, and vice versa, and thus the quantity of vapor taken up by the air may be nicely varied and a desired strength of explosive mixture obtained from different grades of liquid. The adjustability of the inflow-pipe L^3 also has utility in connection with the starting of the engine, the slower initial movement of the piston and the consequent less violence of the inflow of air being compensatable by the adjustment of the mouth of the inflow-tube into closer proximity with the surface of the liquid, the tube being raised to a greater distance than the liquid as the speed increases and being finally set in the position where in the regular operation of the engine it may be found to give the best results.

M represents the rod of an incandescent igniter which may be used in the ordinary way when the electric igniting mechanism illustrated is not employed. Said rod will of course be inclosed within a chimney and

heated by a Bunsen burner in the usual way. As no valve is employed between the ignition-chamber and the interior of the power-cylinder, the ignition of the successive charges will be effected by the incandescent burner at the proper point in the movement of the piston by adjustment of the temperature of the incandescent rod M, also in the usual way.

It is obvious that the improvement in the governing mechanism and that in the electric igniting mechanism may be employed in connection with the use of either gas or vapor in the explosive compound and generally that some of said improvements may be omitted and another or others retained.

For brevity the term "gas-engine" is employed in the following claims to include the apparatus described without reference to whether gas proper or vapor is employed in the explosive mixture.

I claim as my invention—

1. In combination with the ignition-chamber of a gas-engine, a rotary electrode consisting of a head within said chamber carried by a shaft which passes out through the wall of the chamber to connection with suitable devices for rotating it, said head having a contacting prominence on its end face, substantially as described, and a stationary spring-electrode arranged to contact with the said prominence of the rotary electrode and to press the head against the wall of the ignition-chamber during such contact.

2. The combination with the exhaust-valve lever H′ and the rotative shaft G carrying a cam for operating said lever H′, of a hand-lever I mounted on said shaft and provided with an arm I′ adapted to engage the lever H′ whereby the exhaust-valve may be held open at pleasure, substantially as described.

3. In combination with the rotative shaft G and exhaust-valve lever H′, the sleeve h^3 splined on the shaft G and carrying the opposite, offset cams H and h^4 and the screw H^2 engaging with the sleeve and provided with a head h^7 whereby the said screw may be operated by hand to give lengthwise movement to the sleeve upon the shaft, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

GEORGE W. LEWIS.

Witnesses:
M. E. DAYTON,
C. CLARENCE POOLE.