No. 723,502. PATENTED MAR. 24, 1903.

E. THOMSON.

INTERNALLY FIRED ENGINE.

APPLICATION FILED FEB. 28, 1898.

NO MODEL. 2 SHEETS—SHEET 1.

FIG. 1.

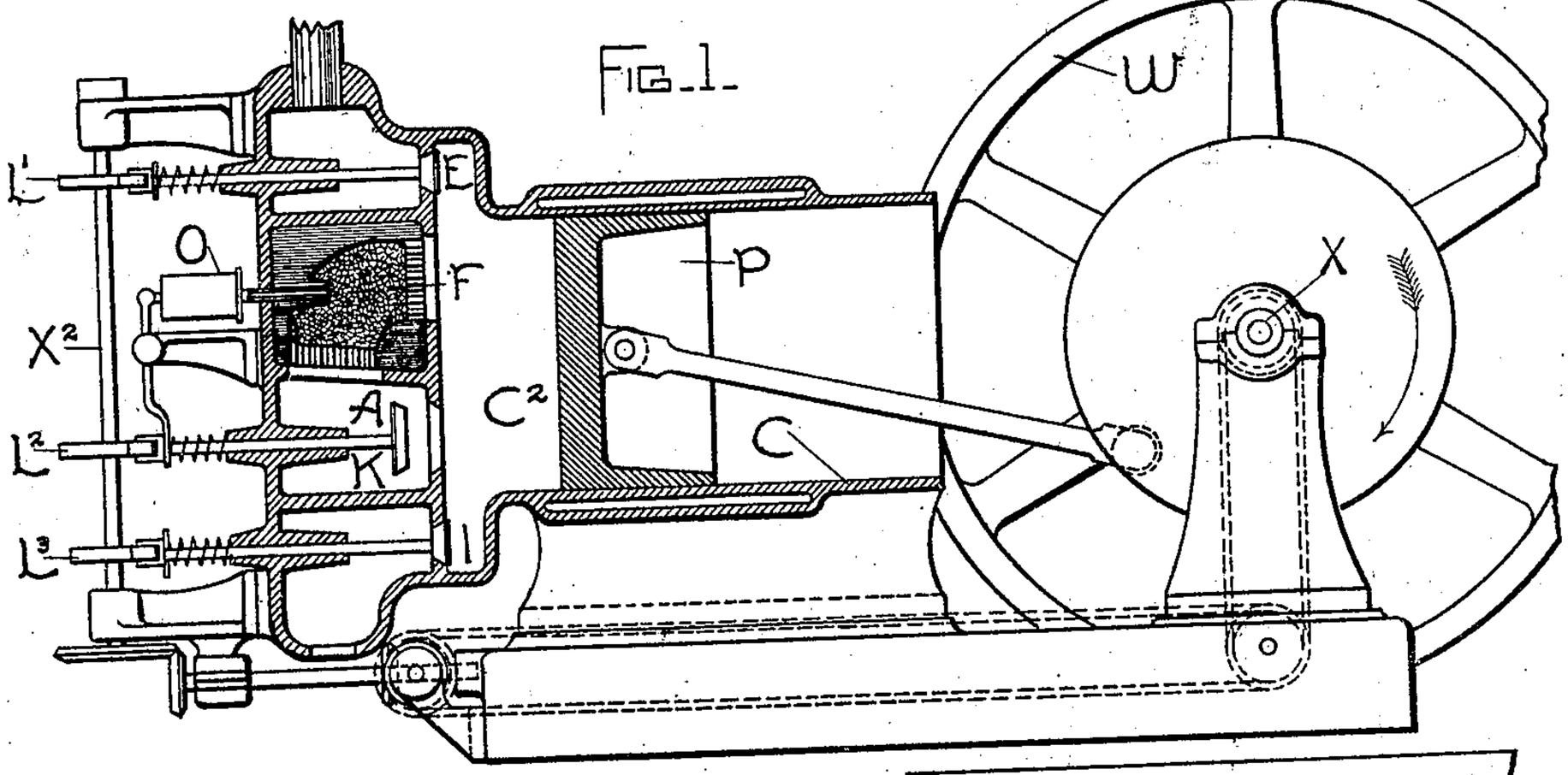


FIG. 2.

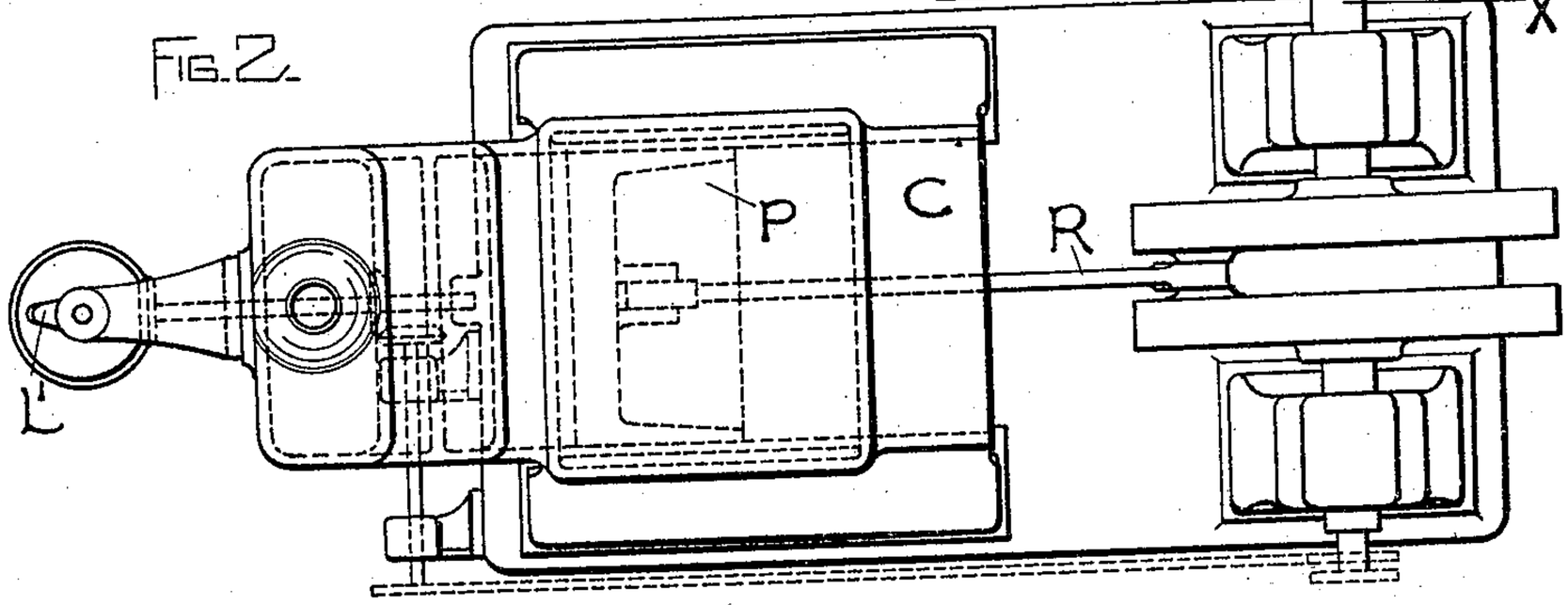
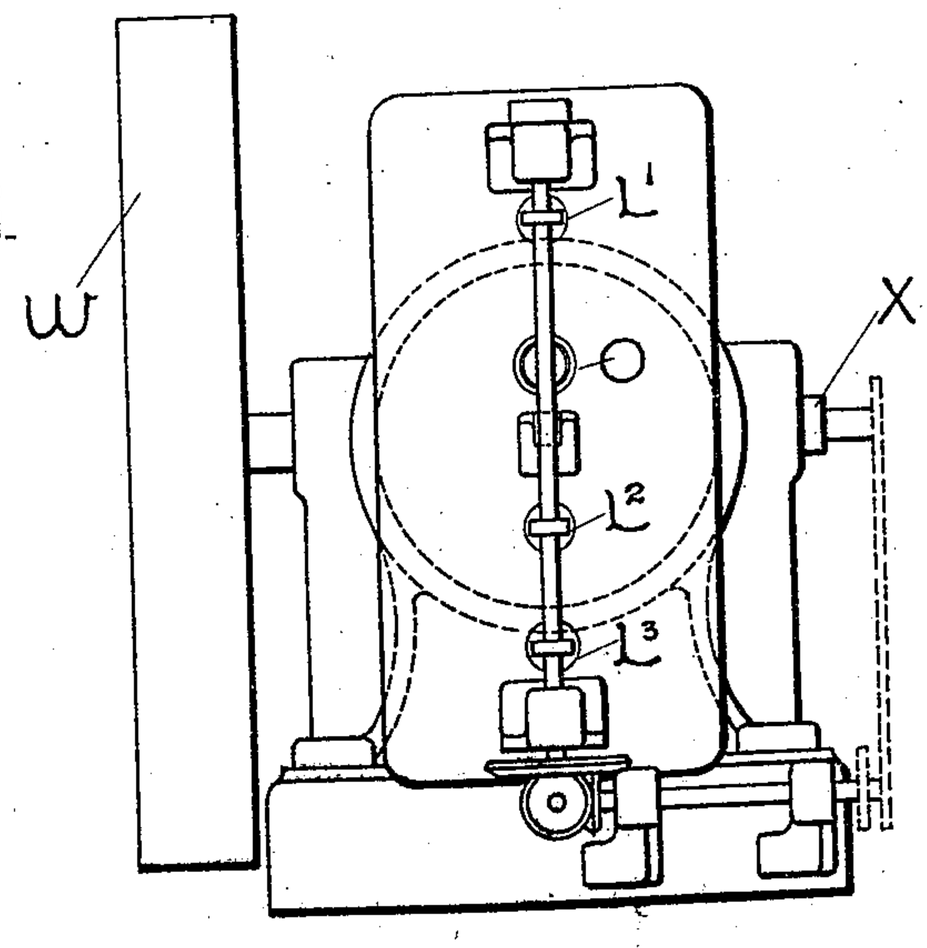


FIG. 3.



WITNESSES.
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Elihu Thomson

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E. THOMSON.

INTERNALLY FIRED ENGINE.

APPLICATION FILED FEB. 28, 1898. 2 SHEETS—SHEET 2.

NO MODEL.

FIG. 4.

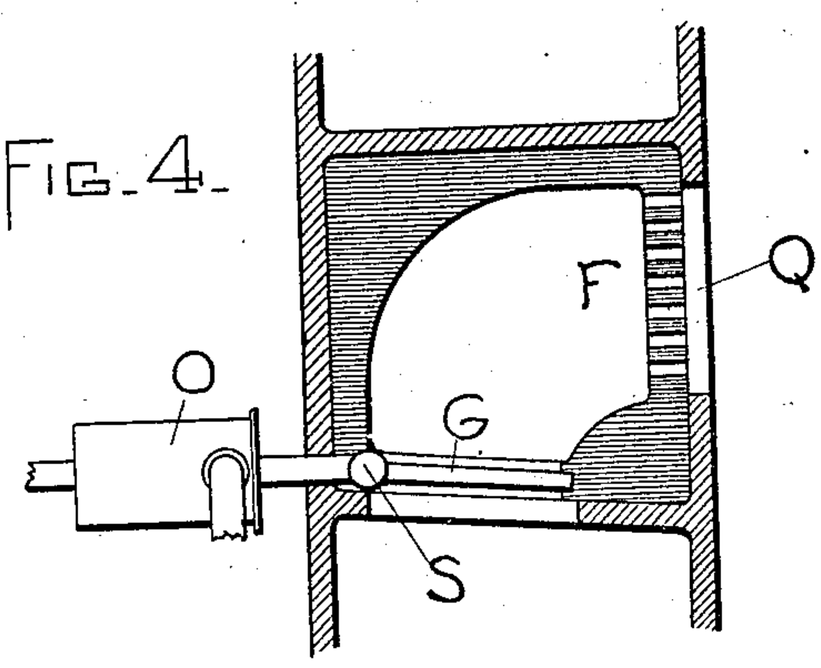


FIG. 5.

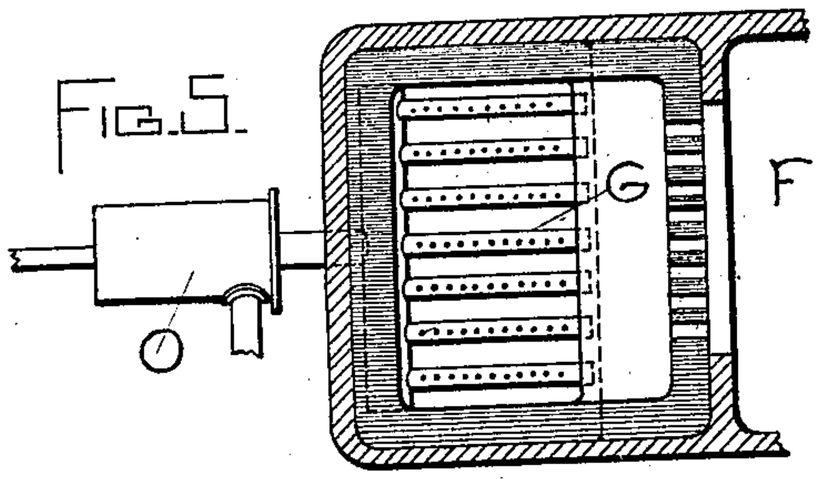


FIG. 6.

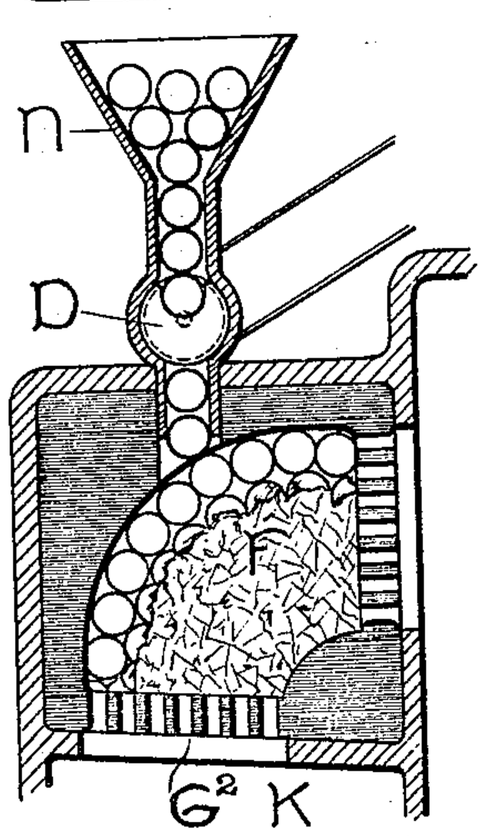
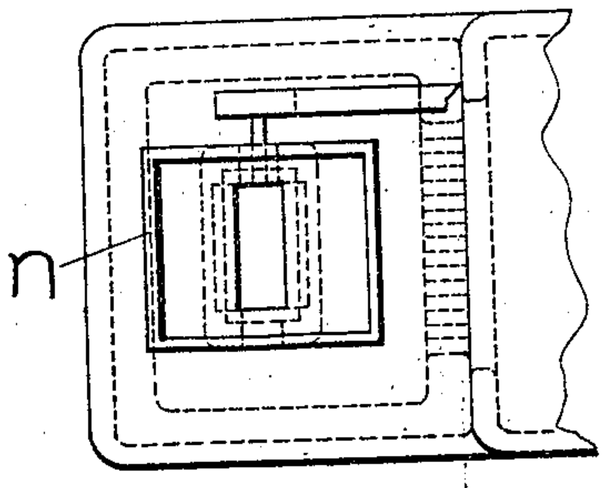


FIG. 7.



WITNESSES.
E. Williams
D. McKillop.

INVENTOR.
Elihu Thomson.

UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS.

INTERNALLY-FIRED ENGINE.

SPECIFICATION forming part of Letters Patent No. 723,502, dated March 24, 1903.

Application filed February 28, 1898. Serial No. 671,963. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing in the town of Swampscott, county of Essex, and State of Massachusetts, have invented a new and useful Improvement in Internally-Fired Engines, of which the following is a specification.

This invention relates to an improvement in internally-fired engines, the object of which is to simplify the production of power from burning fuel and to enable an engine to be constructed which shall burn different kinds of fuel without change of type. I may use in my invention either liquid fuel or gas or oil vapor or solid fuel, such as carbonaceous material. I provide a moving piston which on the forward stroke, for example, takes in a charge of air through an inlet-valve opened during the intake. The cylinder being thus opened and filled with air, the return of the piston compresses the air into a space back of the cylinder and through a valve. This space is adjacent to a fire-body or "interior furnace," so to speak. After the piston has finished the compression of the air on the compression-stroke communication is shut off from the compression-space to the cylinder by the closing of the valve, and the air on expanding returns to the cylinder during the power-stroke through the furnace or fire-pot, in which it meets the combustible and is highly heated by the heat of combustion. Its original volume then becomes increased for any given pressure and the piston is driven forward. Finally the gas is driven out of the cylinder in an expanded or cooled state, due to expansion by the return of the piston and the opening of the exhaust-valve made at the same time.

Reference is had to the accompanying figures, which show an engine embodying my invention.

Figure 1 is a side elevation of an engine, partly in section. Fig. 2 is a plan view of the same. Fig. 3 is an end view or end elevation. Figs. 4, 5, 6, and 7 are details of the fire combustion-chamber or fire-box.

Mounted on a suitable base is a main shaft X, Figs. 1 and 2, having a crank for the coupling of the connecting-rod R, so that piston P may operate or be operated on during the rotation of the driving or fly wheel W. Piston P moves in a cylinder C, the inlet-valve for which is at I, whereby air may be taken in. The exhaust-valve is at E, whereby the gases may be exhausted through proper passages. There is a third valve A, which opens a passage or communication between the cylinder-space C^2 back of the piston P, and a compression box or chamber K, into which the air may be driven when the piston P, having drawn in a body of air on its forward motion, returns with the valve A open. Adjacent to the space or box K is a fire-box or furnace F, lined with refractory non-conducting material and filled with granules, whereby the combustible matter is brought in contact over extended surfaces with the air from K during the power-stroke, and a suitable oil-pump or vapor-pump O discharges combustible liquid, gas, or vapor into the interior refractory filling of the fire-box F, which has perforated slabs separating it from K and from the cylinder-space C^2. A cam-shaft or other suitable means for operating valves I, A, and E, as well as the fuel-pump O, is provided. Thus the shaft X^2 may be suitably geared to the main shaft X and revolve at such a rate as to allow cams L' L^2 L^3 to give the motion of opening and shutting to the valves in any usual manner. As this is not an essential feature of the present invention the mechanism shown is used mainly as suggesting the opening and closure at proper intervals. In the same way the pump O simply typifies a fuel-supply of a regulated amount to the fire-box F. This may be supplied in any way—such as by a reservoir under pressure, by a pump, by gravity, or in any way convenient—it being only necessary that the requisite quantity be supplied to F while the engine is at work. The relation of the parts may be seen in the plan Fig. 2, assisted by the end elevation Fig. 3, where when possible similar parts are represented by similar letters found in Fig. 1 for same parts.

The manner of operation is as follows: Assuming all valves closed at the start, the piston P inward, the valve I is opened by cam L^3. The piston P moves forward, drawing in air. This continues to the end of the intake-stroke. Valve I now shuts. Cam L^2 opens valve A wide, and on the return of piston P the air before drawn in is forced freely

through valve-opening at A into space K, the capacity of which is such with other clearances as to give a predetermined compression-pressure. Valve A is now allowed to shut by cam L^2, and the forward motion of the piston P or power-stroke begins, the air compressed in K being unable to get back to the space C^2 back of the piston, which is increasing, flows through the fire-pot F, and there meets the finely-divided and spread-out fuel within the pot and burns the fuel, assuming, of course, that the fire-pot has been previously brought to a high temperature. The flame and products of combustion shoot forward into the cylinder. This flow continues during the outward motion of the piston during the stroke, and the increase of volume of the air which had been compressed by the high temperature which it has acquired gives the power on expansion. The exhaust-valve E now opens and the piston P returns, driving out the waste gases or products of combustion.

To start the engine, the gas or vapor fed at O may be so highly superheated by passage through a hot tube that on the contact of the air it will fire. This, however, need only be temporarily done, for as soon as the firing of F reaches a high temperature its interior combustion is produced without intermission. In Fig. 4 the fire-pot is shown on a larger scale, and in this case the gas, vapor, or oil is indicated as being pumped into what virtually constitutes hollow grate-bars G in the fire-space. These are tubes having perforations seen in plan Fig. 5, which are branched from a common supply S fed by the fuel-pump or other means. The space within the refractory lining of F (indicated in the figure) is, of course, filled with granules, such as broken fire-brick or specially-molded pieces of refractory material of such size as not to fall through the spaces between the tubes G, forming the grate of the inclosure. The object of the arrangement G is to distribute the fuel, gas, or vapor over the whole area of the fire-box, and thereby prevent its being concentrated and badly mixed with the air. The openings shown at Q are for the passage of the hot products of combustion forward into the cylinder-space and are shown as openings in the lining of F, which is of course refractory.

In Figs. 6 and 7 there is shown the feeding of solid fuel. In this case a hopper N is filled with specially-molded pieces of solid carbonaceous fuel, and by the rotation of the plug D steadily these pieces are received in a groove in one side of the plug D and carried around and dropped into the fire-space in F, where they rest in a heap upon the perforated grate or grill G^2. If, however, the firing-space in F is filled already, the pieces of fuel fail to feed and the rotation of the plug D does not discharge any of them. As soon, however, as they have shrunk within the fire-space F the arrangement begins to feed. If the fit between the plug D and its casing is sufficiently tight, there will be no danger of gas escaping during the process of feeding. In this case the solid fuel itself is burned instead of the vapor fed in as in the former figures. The air compressed in the space K underneath the fire-box passes up through the furnace to the mass of fuel and the oxygen combines with the combustible, keeping up the fire in the fire-pot F in the same way as described in connection with Fig. 1 when gas or vapor is used. The fuel particles fed in by the feeding-plug D may, of course, be granules of carbon such as compressed coke or specially-molded pieces having regularity of form, the constituent being mainly carbon.

Waste gases are discharged, as in Fig. 1, by the exhaust-valve and air for burning fuel taken in likewise, as in Fig. 1, the only difference being in the use of the solid fuel fed into the fire-box instead of liquid, gas, or vapor.

To start the action in F, Fig. 6, requires of course that at the first the mass of fuel shall be hot enough to burn in contact with air. This may be accomplished by heating separately a mass of the fuel-granules and quickly passing them into the fire-box F either through the opening in which the plug D is placed and revolved or through a separate opening afterward closed by a tight-fitting cover.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an internally-fired engine, the combination of a cylinder, a fire-space which communicates with the cylinder through a passage that is always open, a piston arranged to draw in a charge of air on its forward stroke, a valve controlling the admission of the charge, means for closing said valve on the compression-stroke of the piston, a compressed-air compartment communicating with the cylinder-space, means for interrupting the communication between the compartment and the cylinder-space on the second or power stroke of the piston, whereby the compressed charge of air is sent through the fire-space on its return to the cylinder-space, means for supplying fuel to said fire-space, and means for exhausting the return charges on the second return stroke of the piston.

2. In an internally-fired engine, the combination of a piston, a cylinder, a compartment which is in communication with the cylinder-space through a passage which is always open, a second compartment which is in communication with the first compartment through a passage which is always open, and with the cylinder-space through a valve-passage, a valve for opening and closing the said passage between the second compartment and the cylinder-space, means for holding the valve open during the compression-stroke, and closing it during the power-stroke, and mechanism for supplying the fuel to the first-mentioned compartment.

3. In an internally-fired engine, the combination of a piston, a cylinder, a fire-cham-

ber which is in communication with the compression-chamber through a passage, means, such as a pump, for supplying fuel to the fire-chamber, an air-compression chamber adjacent to the fire-chamber, a valve between the compression-chamber and the cylinder-space, and mechanism for closing the valve during the power-stroke.

4. In an internally-fired engine, the combination of a cylinder, a piston moving therein, a valve for admitting air to the cylinder when the piston moves forward, a compressed-air chamber, a valved passage connecting the chamber with the cylinder-space, means for keeping the valve open during the compression-stroke, a fire-chamber which is in communication with the cylinder-space through a passage, and with the air-chamber through a passage which is always open, an exhaust-valve, and mechanism for operating the valves.

5. The combination, in an internally-fired engine, of a cylinder, a piston, a chamber lined with refractory material, said chamber being in communication with the cylinder-space through a passage which is always open, a second chamber for receiving the compressed air which is always in communication with the first-mentioned chamber, and a valve located between the compressed-air chamber and the cylinder-space.

In witness whereof I have hereunto set my hand this 25th day of February, 1898.

ELIHU THOMSON.

Witnesses:
DUGALD MCKILLOP,
HENRY O. WESTENDARP.