No. 861,726. PATENTED JULY 30, 1907.

S. M. HOWELL & F. W. GREEN.

INTERNAL COMBUSTION MOTOR.

APPLICATION FILED MAR. 23, 1906.

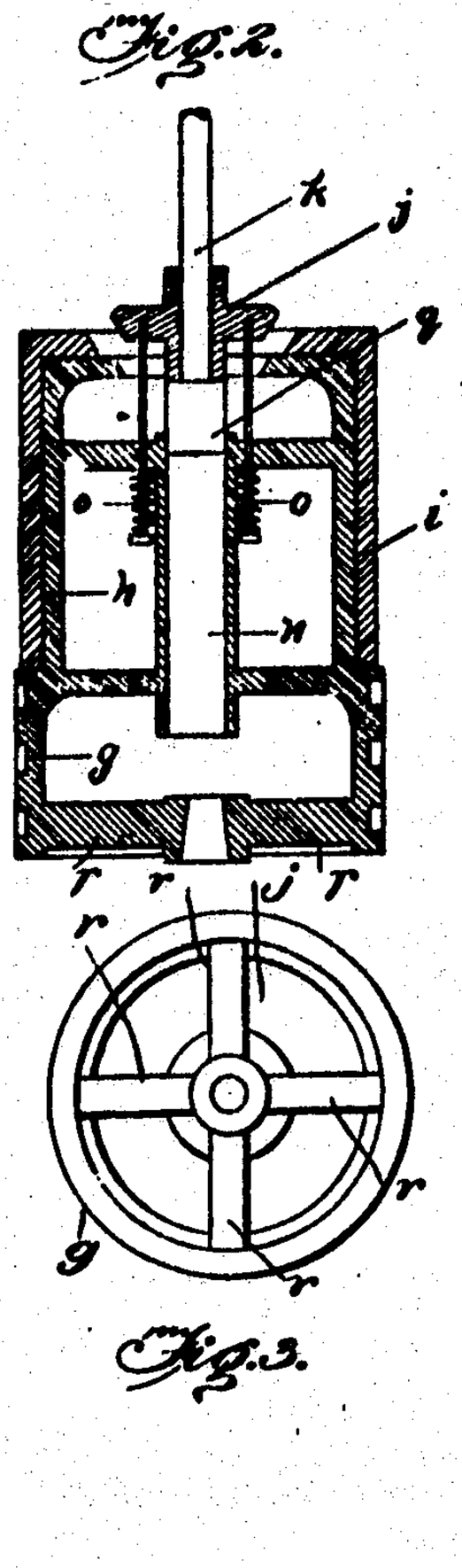

Fig. 2.

Fig. 3.

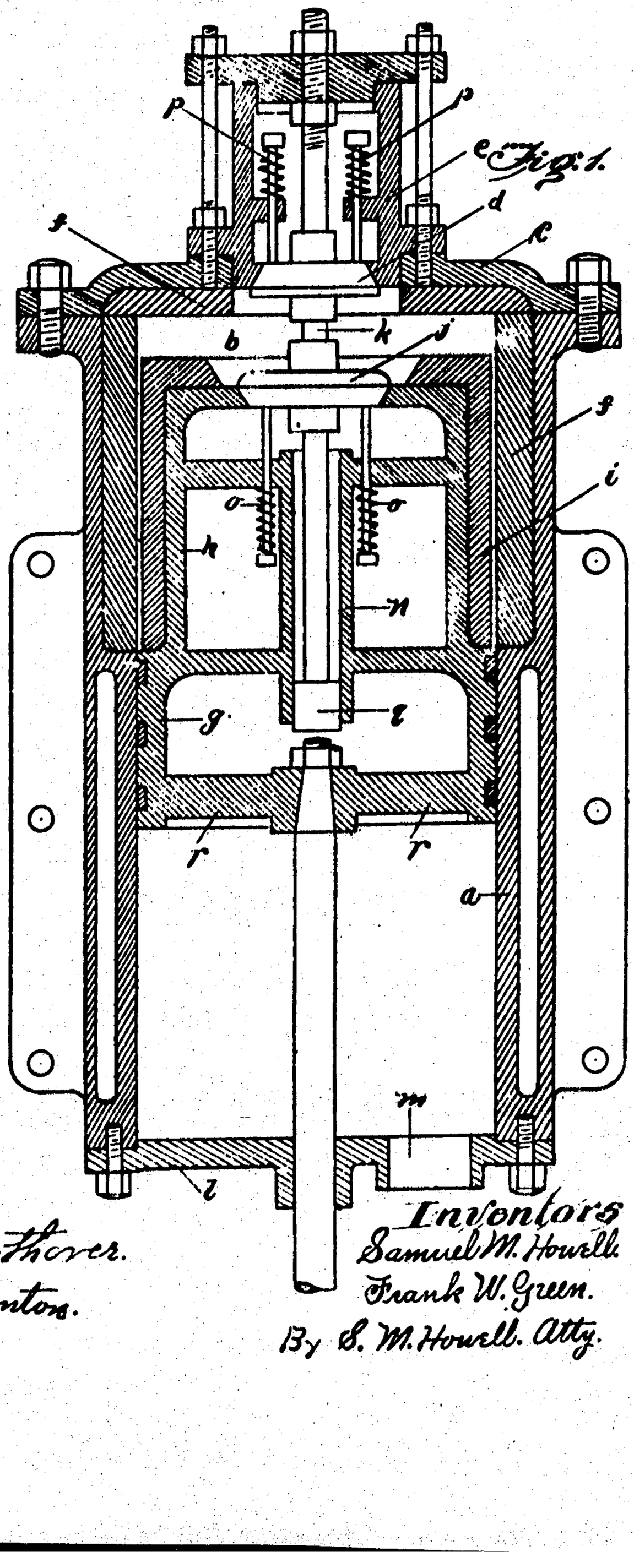

Fig. 1.

Witnesses
James A. Northover.
Perkins Boynton.

Inventors
Samuel M. Howell.
Frank W. Green.
By S. M. Howell. Atty.

UNITED STATES PATENT OFFICE.

SAMUEL M. HOWELL, OF ZANESVILLE, OHIO, AND FRANK W. GREEN, OF LITTLE FALLS, NEW JERSEY.

INTERNAL-COMBUSTION MOTOR.

No. 861,726. Specification of Letters Patent. Patented July 30, 1907.

Application filed March 23, 1906. Serial No. 307,720.

To all whom it may concern:

Be it known that we, SAMUEL M. HOWELL and FRANK W. GREEN, citizens of the United States, and residents, respectively, of Zanesville, in the county of Muskingum and State of Ohio, and of Little Falls, in the county of Passaic and State of New Jersey, have made certain new and useful Improvements in Internal-Combustion Motors, of which the following is a specification.

This invention relates to internal combustion motors, particularly those in which the air and fuel are admitted to the cylinder and fired spontaneously by the heat of compression. The usual practice being to force in a charge of pure air under moderate preliminary compression immediately after the exhaust, and compress the said air to a high degree by the return or instroke of the piston; the fuel being injected at the beginning or during a first fractional part of all of the power stroke and igniting as it enters; and although we prefer this system of operation we do not confine ourselves exclusively to the same; by another method the air and fuel may be stored under high pressure and both admitted to the cylinder simultaneously, either in a mixed state or in separate streams, and ignited and burned during the power stroke as before; or the air alone may be compressed slightly and admitted to the cylinder at or near the termination of the power stroke and strongly compressed as usual by the return or instroke of the piston; the fuel being introduced and the charge instantly exploded at the beginning of the power stroke by the before mentioned heat of compression assisted by means which will hereinafter be described; but the mechanical means by which the preliminary compression of the air and the injection of the fuel may be effected form no part of this invention.

The objects of our improvement are to secure complete combustion of the cylinder charge, and to avoid the loss of heat which is ordinarily incidental to the use of a water jacketed cylinder, and to augment and conserve the heat of compression and thereby assist and render more certain the spontaneous or automatic ignition of the charge, and to provide a motor which is perfectly adapted to the use of any ordinary gaseous or liquid fuel, especially crude or partly refined mineral oil, and to provide a two cycle motor of simple and easy construction in which the imperfections heretofore met with such as back firing, mixing of the new charge with the old &c. will be to a great extent avoided or entirely eliminated, and which will therefore operate with a high degree of thermal or economical efficiency, and develop high power in a motor of comparatively small size and weight; and thus in general afford more satisfactory results than it has heretofore been possible to attain in internal combustion motors.

Having thus briefly outlined the nature and objects of our invention we will now proceed to more fully explain the construction and operation of the same.

Referring to the drawings, Figure 1 is a view partly in section of a cylinder and piston with the valves and valve actuating mechanism all constructed substantially according to our invention, and showing the position of the piston relative to the cylinder at the beginning of the power stroke. Fig. 2 is a view also partly in section but on a smaller scale of the piston and exhaust valve mechanism, showing the position of the exhaust valve relative to the piston at the termination of the power stroke. Fig. 3 is a lower end elevation of the piston, showing the open spaces in the interior of the same.

The cylinder and piston of this motor each consist of two principal parts which will hereinafter be known respectively as the cylinder proper and the combustion chamber, and the piston proper and the piston extension.

Like characters indicate like parts in each view.

In the figures, *a* is the cylinder proper. *b*, the combustion chamber. *c*, the combustion chamber head. *d*, the air admission valve. *e*, the air admission valve case. *f*, refractory lining. *g*, the piston proper. *h*, the piston extension. *i*, the piston extension cap. *j*, the exhaust valve. *k* the actuating rod. *l*, the lower cylinder. head. *m*, the exhaust opening. *n*, the guide tube. *o*, *o*, the exhaust valve springs *p*, *p*, the air admission valve springs. *q*, a circular head or enlargement on the actuating rod as shown.

r denotes a number of radial arms which secure the guide tube *n* to the interior walls of the hollow piston.

The piston proper reciprocates within the cylinder proper in air tight contact as usual. The refractory lining is composed of porcelain, fire clay or other suitable material of like nature; it covers the interior walls of the combustion chamber and its head, and may be of considerable thickness. In the operation of the motor this lining protects the metal parts which it covers from the injurious effects of the heat, and by reason of its nonconducting nature prevents the escape of heat, and tends effectually to maintain the full initial temperature of combustion during the power stroke, and to secure those conditions which are known to be favorable to the prompt ignition of the charge and full and complete combustion of the fuel, and the production of a high temperature, and consequently of high pressure and great power. The piston extension is also covered with a thick cap of the same material as that which forms the said linings and for a similar purpose. The diameter of the piston cap is slightly smaller than that of the combustion chamber bore or that of the cylinder proper, and therefore while the cap

as a fixed part of the piston reciprocates within the combustion chamber and effects the required displacement there is no actual contact of the same with the walls of the combustion chamber lining or those of the cylinder proper, and the length of the combustion chamber lining and piston cap are so proportioned relatively to the length of the stroke that the walls of the cylinder proper are never exposed to the direct impingement of the flame above the piston extension cap. The actuating rod is central with the bore of the cylinder and parallel therewith, and passes centrally through both valves, which fit the same neatly to prevent leakage but slide freely thereon; the purpose of this rod is to open the exhaust valve in a manner hereinafter described; one of its ends is secured to the upper part of the air admission valve case, the other terminating in a circular head or enlargement as shown; the rod having no relative motion but remaining stationary at all times during the operation of the motor; its position is adjustable however in a direction parallel with its length by means of the threaded portion which secures the rod to the said valve case as shown in the drawing. The guide tube is a straight tubular body of circular cross section, the bore of which fit neatly around the head of the actuating rod and slides freely thereon; this tube is permanently fixed as regards its position in the piston, and may be of a separate part or material secured to the piston in any suitable manner or cast integral therewith as shown in the drawing; the purpose of this tube is to guide or steady the actuating rod and prevent lateral vibration of the same. The valve springs act to close the valves and hold the same down upon their seats except when the tension of said springs is over come and the valves are forced open by means which will presently appear.

The operation of the motor is as follows, When the piston in its outward movement has arrived at a predetermined point near the termination of the power stroke, the exhaust valve comes in contact with the head of the actuating rod and by the further motion of the piston is forced open until the end of the power stroke is reached, and the valve is wide open as shown in Fig. 2; the spent gases of the burned charge escaping through the hollow interior of the piston and passing out at the exhaust opening in the lower cylinder head: the pressure in the combustion chamber having been thereby reduced to the level of the atmosphere, a supply of air previously compressed to a moderate degree, as before mentioned, and led into the air admission valve case through an opening not shown in the drawing, forces open the air admission valve and enters the combustion chamber, driving out and displacing the remainder of the burned charge; meanwhile the crank having passed the center, the retreat of the piston permits the exhaust valve to close under the action of its springs and the rising pressure in the combustion chamber causes the air admission valve to close in like manner; the return of the piston compresses the inclosed air to a high degree preparatory to the introduction and ignition of the fuel near the beginning of or during the following power stroke; the fuel entering the combustion chamber through an opening not shown in the drawing but which may be located at any suitable point in the walls of the combustion chamber or its head.

As matters of preference we have shown the cylinder proper of this motor surrounded by a water jacket, and also constructed with a lower head and a piston rod passing through the same in suitable arrangement for the reception of a cross head; but we are not restricted entirely to the use of either of these devices; the said jacket may be dispensed with or replaced by ribs or other projections usually employed to increase the radiating surface and effect the cooling by contact with the surrounding atmosphere. The front head may also be omitted and the connecting rod coupled directly to a pin or wrist within the piston as is usual in gas engine practice, and the exhaust discharged from the open end of the cylinder or into what is known as an inclosed crank case, and delivered from there to a pipe or the open air; we have also shown the combustion chamber head as being of separate part to be secured in place by bolts; we prefer this arrangement but are not confined to it; the said head might be cast integral with the walls of the combustion chamber and thus form a continuous part of the same. Also, the valves with the actuating rod, guide tube, and their coöperating parts constructed and operated as we have shown and described, may be used in the same manner without the piston extension or its cap of refractory material, and without the combustion chamber lining of refractory material, yet we prefer the combination of all these features as shown in Fig. 1, of the drawings. We prefer too, to locate the valves with the actuating rod, guide tube, and their coöperating parts in the longitudinal center line of the cylinder, as we have shown, but this is not essential; the said parts may be arranged on one side of the said longitudinal center line. We prefer also, to ignite the charge automatically as herein before stated, by the heat of compression, but this is not a necessity; the ignition may be effected by any other suitable means.

Regarding the piston of this engine, it should be understood that the guide tube *n*, and also the piston rod, are each secured to the said piston by two or more arms *r*, shown in section in Figs. 1 and 2; or by other suitable means which permit the free and unobstructed passage to the lower end of the cylinder proper, and thence to the atmosphere, of the exhaust gases coming from the combustion chamber through the valve *f* as before explained.

We are aware that extended pistons with cylinders of corresponding form, pistons having exhaust valves therein, and combustion chambers lined with blocks or pieces of refractory or nonconducting material, and also that various combinations of the same, have been constructed and used before. These forms of construction, however, have not been used in connection with our improvements, nor have they been used in exactly the manner in which we employ them.

What we claim and wish to secure by Letters Patent is.

1. In an internal combustion motor comprising a cylinder, a reciprocating piston, and a stationary actuating rod; an exhaust valve located in said piston, and adapted to discharge the exhaust gases through the piston and the lower portion of the cylinder, substantially as shown and described.

2. In an internal combustion motor comprising a cylinder, a reciprocating piston and an exhaust valve located in said piston: a stationary actuating rod secured to the upper portion of the cylinder and adapted to force open the

exhaust valve by the motion of the piston, substantially as shown and described.

3. In an internal combustion motor comprising a cylinder, a reciprocating piston, a piston contained exhaust valve, and an actuating rod; a guide tube located in the piston and adapted to guide on steady the actuating rod substantially as shown and described.

4. In an internal combustion motor comprising a cylinder and a reciprocating piston; an air admission valve and an air admission valve case centrally located in the head or upper portion of the cylinder or combustion chamber, an exhaust valve and a guide tube centrally located in the piston, an actuating rod secured at its upper end to the air admission valve case or cylinder and passing centrally through the air admission and exhaust valves and terminating in a head or enlargement over which the guide tube is adapted to slide with the reciprocating motion of the piston, the exhaust and air admission valves being adapted to move freely on the actuating rod in a direction parallel with its length, the exhaust valve opening by contact with the head or enlargement of the actuating rod when the piston is near the terminal part of the power stroke, substantially as shown and described.

5. In an internal combustion motor, the combination with a cylinder and reciprocating piston comprising a cylinder proper, combustion chamber, combustion chamber lining of refractory material, piston proper piston extension, piston extension cap of refractory material; of an air admission valve, and an air admission valve case centrally located in the combustion chamber head, an exhaust valve and a guide tube centrally located in the piston, an actuating rod secured at its upper end to the air admission valve case and passing centrally through the air admission and exhaust valves and terminating in a head or enlargement over which the guide tube is adapted to slide with the reciprocating motion of the piston; the exhaust and air admission valves being adapted to move freely on the actuating rod in a direction parallel with its length, the exhaust valve opening by contact with the head of the actuating rod when the piston is near the terminal part of the power stroke, substantially as shown and described.

SAMUEL M. HOWELL.
FRANK W. GREEN.

Witnesses:
JAMES A. VORTHOVEN.
PERKINS BOYNTON.