(No Model.)

T. SMALL.

GAS ENGINE.

No. 581,784. Patented May 4, 1897.

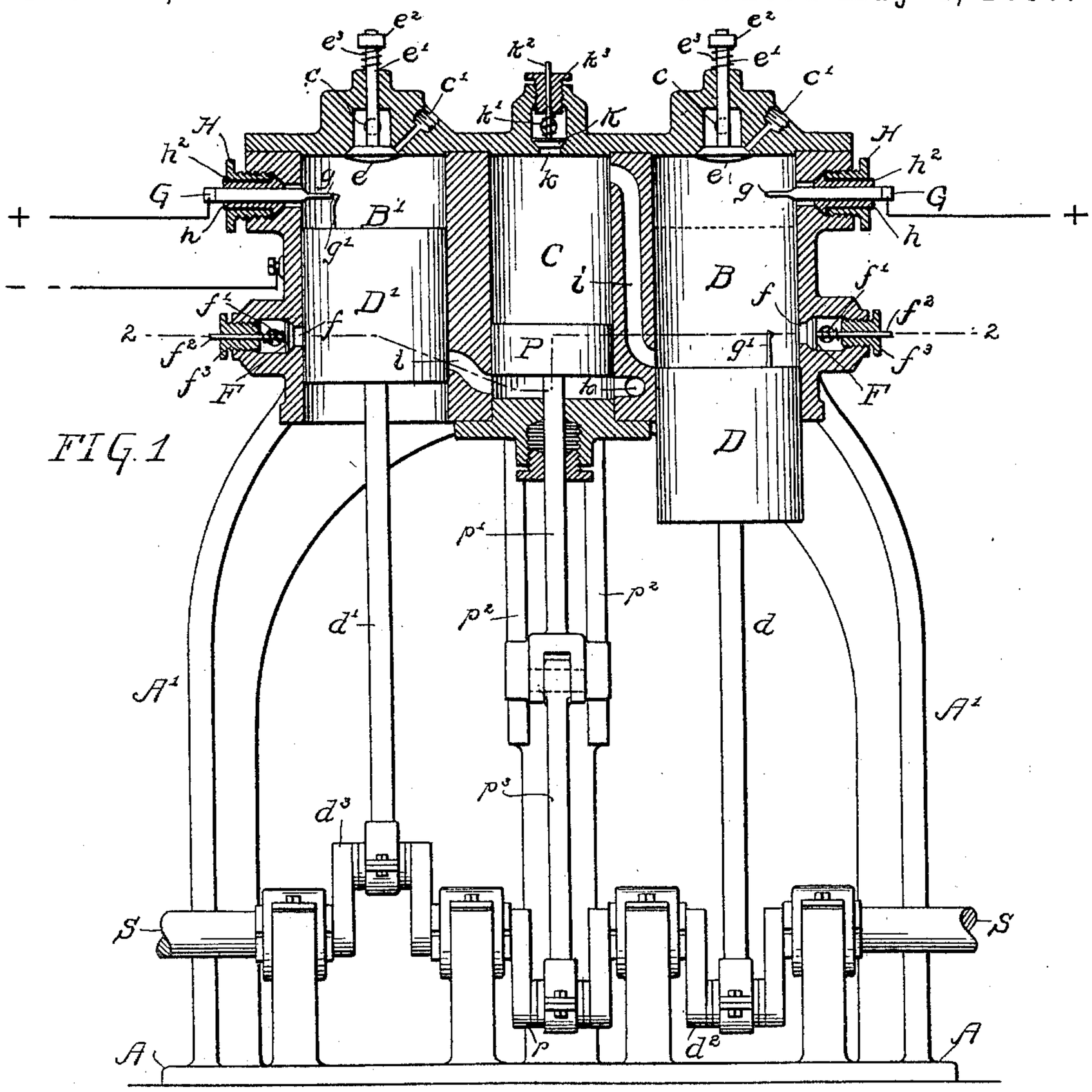

FIG. 1

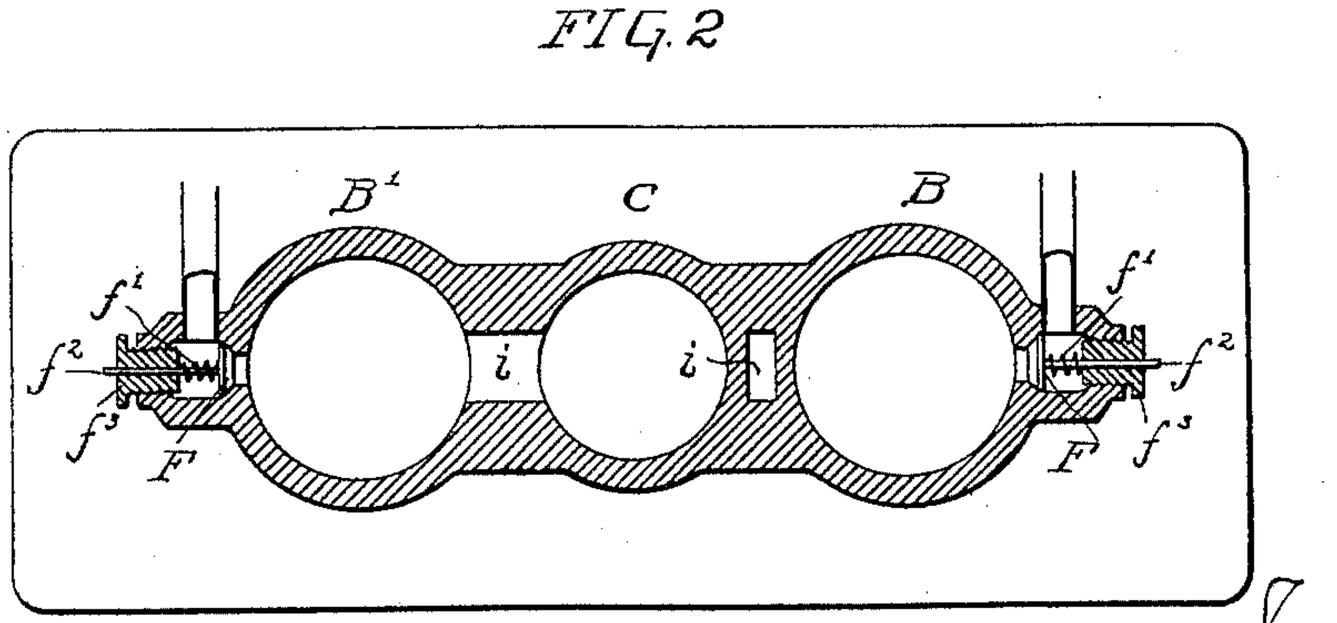

FIG. 2

Witnesses:
Jno. E. Parker
J. Henderson.

Inventor:
Thomas Small,
by his Attorney,
Howard Pell

UNITED STATES PATENT OFFICE.

THOMAS SMALL, OF CAMDEN, NEW JERSEY, ASSIGNOR TO GEORGE J. RICHARDSON, TRUSTEE, OF PHILADELPHIA, PENNSYLVANIA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 581,784, dated May 4, 1897.

Application filed April 11, 1896. Serial No. 587,186. (No model.)

To all whom it may concern:

Be it known that I, THOMAS SMALL, a citizen of the United States, and a resident of Camden, county of Camden, State of New Jersey, have invented certain new and useful Improvements in Gas-Engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification.

My invention has relation to certain improvements in gas-engines, and has among its objects to provide alternatingly-operating cylinders of the type described and claimed in my application for Letters Patent of the United States filed of even date herewith, Serial No. 587,184, combined in one coacting mechanism, with a single pump or exhausting apparatus for alternatingly removing from the respective cylinders the exploded gases and the products of combustion after each forward stroke of the piston, as hereinafter more particularly set forth and described.

In the accompanying drawings I illustrate an apparatus embodying my invention.

Figure 1 is a sectional plan view representing a given position of the respective reciprocating pistons in their respective cylinders and illustrating the mechanism preferably employed in carrying out my invention. Fig. 2 is a cross-sectional view on the line 2 2, Fig. 1.

In carrying out my invention I so combine the two power-cylinders that the pump or exhausting apparatus will exhaust the exploded gases and products of combustion from each of the cylinders alternately, a partial vacuum being maintained in the pump-cylinder so connected that just before the respective pistons of the power-cylinders reach their full forward movement the port connecting the pump-cylinder with the particular power-cylinder in which the piston has reciprocated nearly to its full forward movement will be opened and the partial vacuum previously established in the pump-cylinder will at once exhaust the exploded gases and products of combustion from the power-cylinder and simultaneously draw in the necessary charge of air and gas.

A represents the main casting, properly supported upon a suitable foundation, preferably upon the uprights A′.

B B′ are the two power-cylinders, similarly constructed, being preferably an integral part of the main casting.

C is the pump-cylinder, intermediately situated between the cylinders B B′.

D D′ are the reciprocating pistons of the power-cylinders B B′, connected, respectively, through the medium of the piston-rods *d d′* with the cranks d^2 d^3, provided upon the main shaft S, which said cranks d^2 d^3 hold diametrically opposite positions upon the shaft S to operate alternately the pistons D D′.

c c′ of the respective power-cylinders represent air and gas inlets, having the automatically-operated valve *e* to open and close said air and gas inlet ports. The valve *e* is provided with a stem *e′*, projected through and guided by an opening in the cylinder-head, and is provided with an adjusting-nut e^2, between which and the cylinder-head is coiled a compression-spring e^3, normally acting to hold the valve to its seat and normally to prevent the entrance of air and gas into the cylinder.

On that side of the cylinder opposite the port *i* is a high-pressure escape-port *f*, closed by a check-valve F, opening outwardly and provided with a coiled compression-spring *f′*, surrounding its stem f^2, the tension of the spring being regulated by a gland-nut f^3. The port *f* is arranged slightly above the port *i*, so that the surplus pressure of gases may escape before the port *i* is uncovered by the piston.

The sparking device in the present instance comprises an electrode *g* in the form of a tongue projecting from the rod G, which finds a bearing in a collar *h*. This collar is held in place by a gland-nut H, insulated from the collar by a sleeve h^2, of rubber or other insulating material. The opposite electrode *g′* is carried by the piston and is in the form of a spring-finger, which comes in contact with the tongue *g* as the piston moves to the rear, the relative position of the parts being such that as the piston reaches its highest point the electrode *g′* will wipe over the tongue *g*, and when the piston again starts its forward movement the parting of the two electrodes

will, in breaking electrical contact, create a spark and ignite the explosive charge.

The sparking device, as herein described, may be altered in any suitable manner or any approved form of sparking device be substituted therefor.

The ports *i* connect the forward ends of their respective cylinders with the opposite ends of the pump-cylinder, as indicated in the drawings.

At each end of the pump-cylinder is an escape-port *k*, closed by a check-valve K, opening outwardly and provided with a coiled compression-spring *k'*, surrounding its stem *k²*, the tension of the spring being regulated by a gland-nut *k³*.

The pump-piston P is connected with the crank *p* of the shaft S through the medium of the rod *p'*, guided on the rails *p²*, and the connecting-arm *p³*. The usual fly or balance wheel is provided upon the shaft S.

The operation is substantially as follows: Assuming the respective pistons to occupy the relative positions shown in Fig. 1, a charge of air and gas having been drawn into cylinder B in the manner hereinafter described, and the piston D in the act of ascending its cylinder, the air and gas in said cylinder B will be compressed by such upward motion of the piston D until the full extent of the stroke is reached, (indicated by the dotted line across said cylinder near the upper portion of the same.) The charge will then have been fully compressed, and the electrode *g'* will have come into electrical contact with the electrode *g*, as indicated in Fig. 1 in cylinder B'. As the piston D commences to descend upon the downward stroke the contact between the electrodes *g g'* will be broken, at which time the igniting-spark will be produced. The compressed charge of air and gas will immediately explode, driving the piston D rapidly downward. As the downward travel of the piston D opens the port *f* the high-pressure exploded gases will find means of escape through said port *f* by automatically opening the valve F. The pump-piston P, as shown by the mechanical connection in the drawings, ascends with substantially the same extent of thrust in its cylinder C as does the piston D to the position indicated by the dotted line in the upper portion of the cylinder C, driving the air, exploded gases, or other contents of the cylinder C before it through the port *k*, the pressure being sufficient to open the one-way valve K against the tension of spring *k'*, the port *k* being the only means of escape for the contents of the cylinder C, as the connection of the port *i* will be closed by the walls of the barrel-piston D in its upward travel in the cylinder B, the wall of the piston D being sufficiently elongated to keep the port *i* always closed after the face of the piston shall have passed the upper line of the mouth of the port *i*. The port *i* being still closed, as the pump-piston P proceeds to descend the action of the said piston creates in the cylinder C a partial vacuum until the piston D in its downward travel commences to pass the mouth of the port *i*, when immediately the remaining exploded gases and products of combustion contained in the cylinder B are by said partial vacuum at once exhausted through the port *i* into the chamber C. The exhaust action of the piston P, as just described, not only exhausts the exploded gases and products of combustion from the cylinder B, as just described, but the partial vacuum thereby created in the cylinder B allows simultaneously the check-valve *e* to be opened through the pressure of the air and gas from without and a supply of air and gas to be injected into the cylinder B to form the necessary charge to be compressed and exploded successively. The check-valve F, hereinbefore described, is provided to assist the exhaust of the exploded gases and products of combustion from its cylinder, the tension of the spring connected with said valve being so regulated as to allow the pressure of the gases as the piston D begins to pass the port *f* to partially open the said valve and to permit part of the exploded gases to pass thereout.

While the piston D and the pump-piston P are traveling in their upward movement in their respective cylinders, as hereinbefore described, the piston D' is descending at the same speed, to the same extent of travel, in the cylinder B' until when the piston D and the pump-piston P are fully up in their respective cylinders the piston D' is full down, at this time occupying the same position in its cylinder B' as that represented in Fig. 1 by the piston D in its cylinder B. As the downward travel of the piston D' opens the port *f* the high-pressure exploded gases will find means of escape through said port *f* by automatically opening the valve F, as described in reference to cylinder B. As the pump-piston P makes its primary ascent, as hereinbefore described, the tendency is to produce in the cylinder C, back of the piston-head, a partial vacuum in the same manner as hereinbefore described on the reverse action of the piston. Therefore immediately upon the port *i*, leading into the cylinder B', being opened by the descent of the piston D' the contents of the cylinder B' would be at once exhausted into the cylinder C and a charge of air and gas drawn in simultaneously through the valve *e* into the cylinder B' by reason of the partial vacuum therein formed, as hereinbefore described in referring to the cylinder B. The upward travel of the piston D' will then compress the charge of air and gas, which will be duly exploded and the piston driven down and the exploded gases and products of combustion exhausted in the manner hereinbefore described, the construction of the two cylinders and their connection being substantially the same. The exploded gases and products of combustion from the cylinder B' exhausted into the cylinder C are upon the

next downward movement of the piston P forced through the port k^4, which is provided with a one-way valve, similarly constructed to the valve K, mounted above the cylinder C.

An economically-constructed double-acting gas-engine producing an explosion for every half-revolution of the shaft is thus provided, having a single exhaust mechanism for exhausting the exploded gases and products of combustion from the respective power-cylinders alternately after every downward stroke of the pistons in the said cylinders and simultaneously drawing in a new charge of air and gas and creating an explosion at every half-revolution of the shaft.

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

1. A double-acting gas-engine having two alternately-operating power-cylinders, each having a reciprocating piston, automatically-operated air and gas inlet valves provided at or near one end of the cylinder, high-pressure escape-valve, an exhaust-port for exhausting the remaining products of combustion, and simultaneously drawing in a new charge, means for automatically igniting the charge when under compression, a double-acting pump, the opposite ends of the cylinder of which are connected with the exhaust-ports of the power-cylinders respectively for exhausting the products of combustion at or about the time the reciprocating piston of each power-cylinder approaches the lower end of its said cylinder or full forward stroke, crank-shaft and connecting-arms and parts connecting the respective pistons to the said shaft, substantially as described.

2. In a gas-engine, cylinders, B, B′, reciprocating pistons, D, D′, pump-cylinder, C, piston, P, provided therein, crank-shaft, S, and connecting-rods and arms connecting the respective pistons with the said shaft, air and gas inlet valve provided in each of the cylinders, B, B′, at one end thereof adapted to be opened by the force of the air and gas when a partial vacuum is created in the respective cylinders, high-pressure escape-valve, F, exhaust-port, *i*, connecting each of the said cylinders with the pump-cylinder, C, at or near opposite ends thereof, igniting mechanism provided in each of the cylinders, B, B′, for exploding the charge of air and gas under compression, one-way valve provided in the pump-cylinder, C, at or near opposite ends thereof to allow of the escape of the products of combustion and exploded gases from the said cylinder, C, under the action of the piston, P, substantially as described.

3. In a gas-engine, cylinders, B, B′, each having a combined compression and explosion chamber, reciprocating pistons, D, D′, pump-cylinder, C, double-acting piston, P, provided therein, crank-shaft, S, and connecting rods and arms connecting the respective pistons with the said shaft, air and gas inlet valve provided in each of the cylinders, B, B′, at one end thereof, exhaust-port, *i*, connecting each of the said cylinders with the pump-cylinder, C, at or near opposite ends thereof, electrically-connected electrodes, *g*, *g′*, for exploding the compressed charge at stated intervals, one-way valves provided in the pump-cylinder, C, at or near the opposite ends thereof to allow of the escape of the exploded gases and products of combustion from the cylinder, C, under the action of the piston, P, and auxiliary escape-ports, *f*, in the cylinders, B, B′, provided with spring-tensioned one-way valves to assist in the escape of the exploded gases and the products of combustion from their respective cylinders, substantially as described.

In witness whereof I have hereunto set my hand this 2d day of April, A. D. 1896.

THOMAS SMALL.

Witnesses:
JNO. E. PARKER,
EDMUND S. MILLS.