(No Model.)

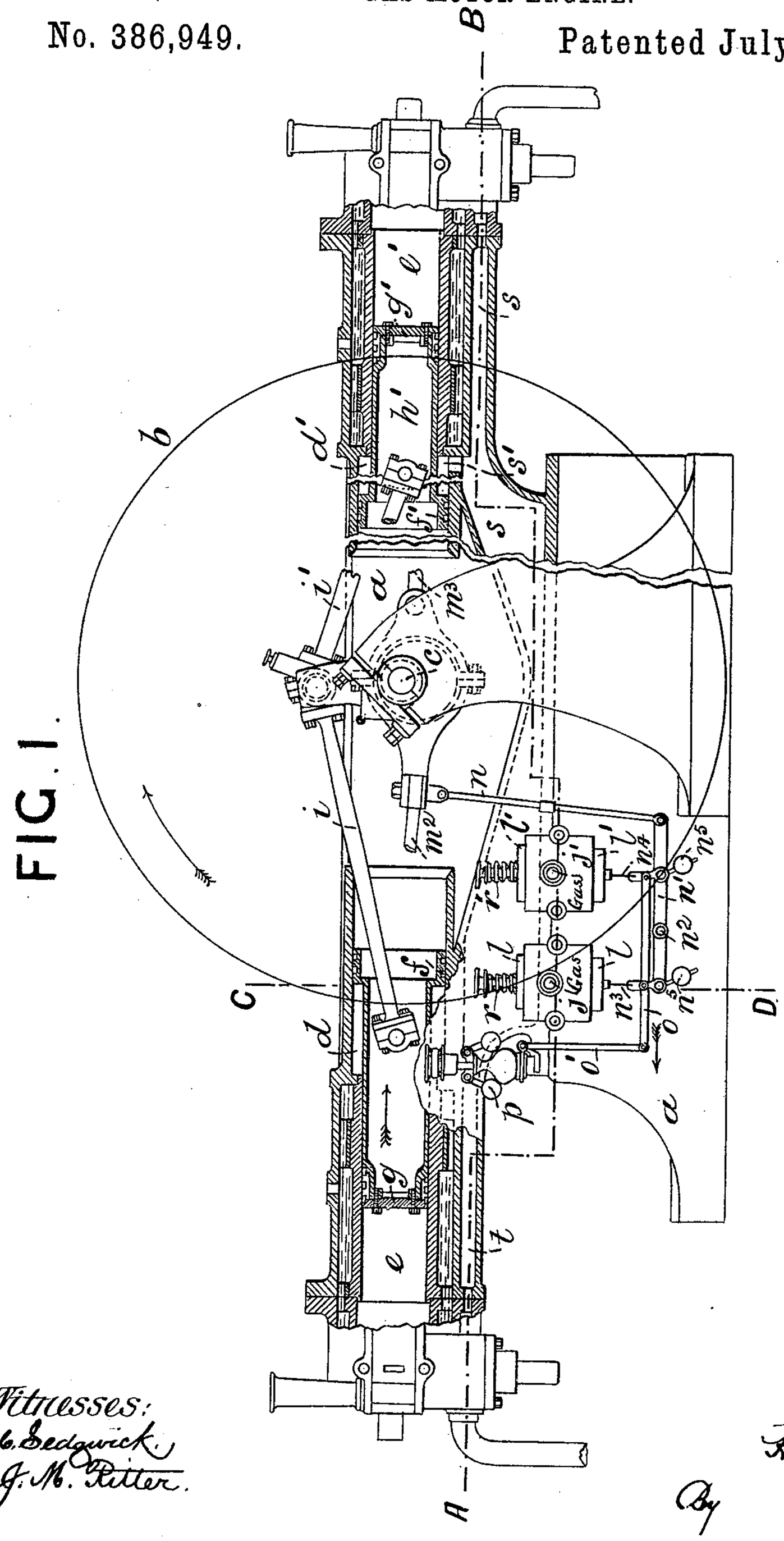
3 Sheets—Sheet 1.

H. WILLIAMS.

GAS MOTOR ENGINE.

No. 386,949. Patented July 31, 1888.

FIG. 1.



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(No Model.) 3 Sheets—Sheet 2.

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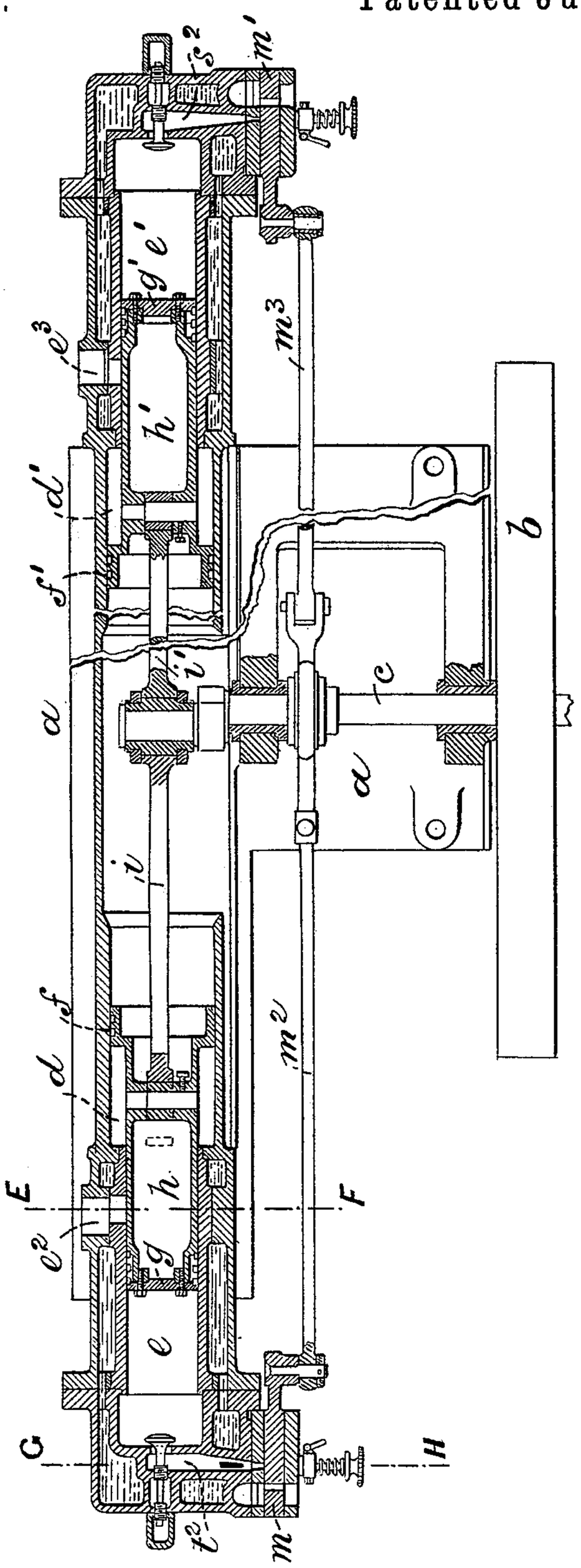
FIG. 2.



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(No Model.) 3 Sheets—Sheet 3.

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FIG. 5.

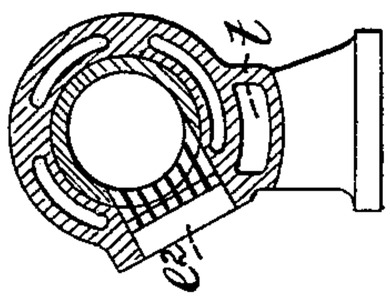


FIG. 6.

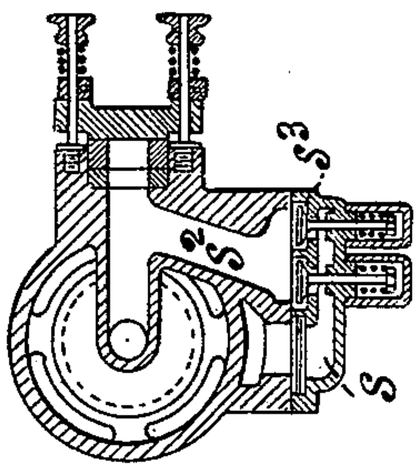


FIG. 4

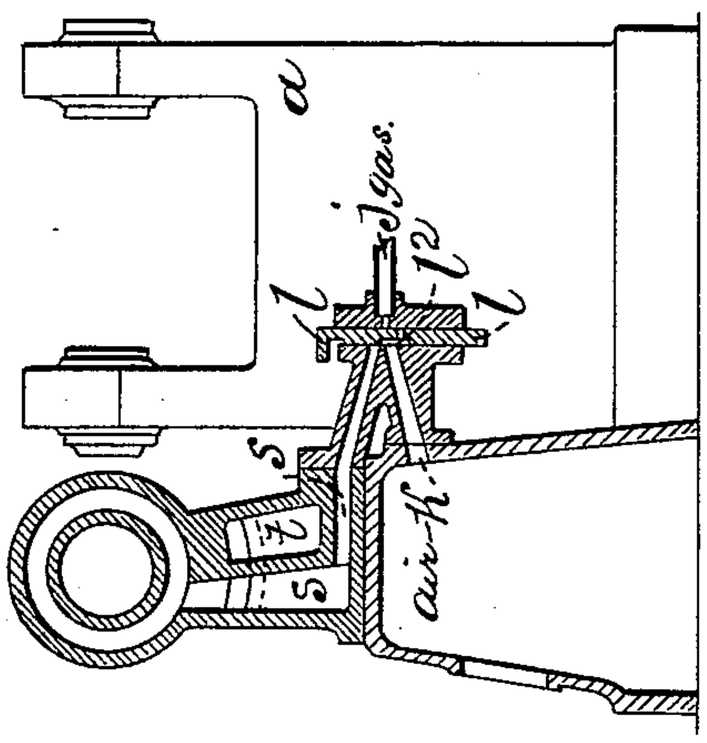
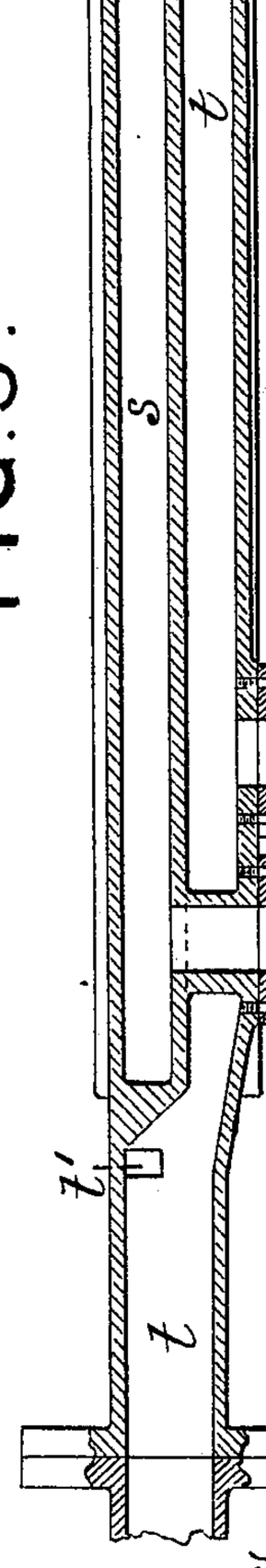


FIG. 3.



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UNITED STATES PATENT OFFICE.

HUGH WILLIAMS, OF STOCKPORT, COUNTY OF CHESTER, ENGLAND.

GAS-MOTOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 386,949, dated July 31, 1888.

Application filed January 23, 1888. Serial No. 261,633. (No model.)

To all whom it may concern:

Be it known that I, HUGH WILLIAMS, a subject of the Queen of Britain, and a resident of Stockport, in the county of Chester, England, have invented new and useful Improvements in Gas-Motor Engines, of which the following is a specification.

This invention relates to an invention for which I made application for Letters Patent of the United States on the 23d day of January, 1888, Serial No. 261,632. In the specification to that said application I described and the drawings showed a gas motor engine arranged substantially as follows: A compound cylinder consisting of a charging-cylinder and a power-cylinder of two different diameters with a charging-piston and a power-piston each fitted to the diameter of its respective cylinder and combined and operating as a single piston; also, a passage for the admission and discharge of mixed gas and air to and from the charging-cylinder, and a valve for alternately placing said passage in communication with the gas and air inlets and with a reservoir for the storage of the charge compressed into it by the action of the charging-piston until at the proper moment the said charge was free to flow through a valve into the power-cylinder, where it was subsequently compressed by the power-piston and then exploded.

Now, my present invention consists, chiefly, in employing duplicate engines of substantially the construction specified in my said application, the two engines being coupled to one and the same crank shaft.

In order that my invention may be fully understood and readily carried into effect, I will describe the accompanying three sheets of drawings, reference being had to the figures and letters marked thereon.

Figure 1 is a side elevation, and Fig. 2 a plan, both partly in section, of a gas-motor engine constructed and arranged according to my present invention. Fig. 3 is an irregular sectional plan of the gas and air admission valves and their passages. This view is taken on the plane of the line A B, Fig. 1. Figs. 4, 5, and 6 are transverse vertical sections taken, respectively, on the lines C D, Fig. 1, E F, and G H, Fig. 2.

Similar letters refer to similar parts throughout the several views.

a designates the frame or main casting of the engine, *b* the fly-wheel, and *c* the crank-shaft. Each compound cylinder is bored to two diameters to form two sets of cylinders, *d d'* and *e e'*, which are fitted with pistons *f f'* and *g g'* of corresponding diameters. The larger cylinders, *d d'*, are those into which the charges of mixed gas and air are drawn by the charging-pistons *f f'*, and the smaller cylinders, *e e'*, are the power-cylinders, in which the said charges are compressed and ignited to actuate the power-pistons *g g'*. The pistons of each pair are respectively formed with or connected together by a hollow trunk, *h h'*, which trunks are connected by rods *i i'* to the crank-shaft *c*.

The gas-inlets *j j'*, Figs. 1, 3, and 4, and the air-inlets *k*, one of which is shown in the sectional view, Fig. 4, are controlled by two vertically-reciprocating slide-valves, *l l'*, which are operated from the same eccentric on the crank-shaft *c*, which operates the ordinary slide ignition-valves, *m m'*, by means of the connecting-rods m^2 m^3. The slide-valves *l l'* are operated by means of a rod, *n*, jointed at one end to the reciprocating connecting-rod m^2, and at the other end to a lever, *n'*, pivoted on the frame at n^2. On the lever *n'* are pivoted two fingers, n^3 n^4, which are weighted at n^5, and are jointed to a rod, *o*, which is pivoted to a rod, *o'*, connected to the governor *p*. In each of the valves *l l'* there is an opening and a passage, l^2, (see Fig. 4,) and the valves are weighted with springs *r r'*, (see Fig. 1,) which keep them normally closed to prevent the entrance of gas from the inlets *j j'* and air from the inlets *k;* but when the reciprocating connecting-rod m^2 by means of the rod *n* rocks the pivoted lever *n'* on its fulcrum n^2 the said lever by means of the fingers n^3 n^4 alternately raises first one and then the other slide-valve *l* or *l'*, so as to place the opening therein opposite the gas-inlet, and by means of the passage l^2 to connect the air-inlet *k* with a passage, *s* or *t*. Of these the passage *s* leads to an inlet, *s'*, into the charging-cylinder *d'*, and also to an inlet, s^2, (see Figs. 2 and 6,) controlled by non-return valves s^3, to the power-cylinder *e'*, while the passage *t* leads to an inlet, *t'*, into the charg-

ing-cylinder *d*, and also to an inlet, t^2, into the power-cylinder *e*, controlled by non-return valves, (not shown, but exactly similar to the valves s^3, Fig. 6.) The slide-valve *l* governs the passage *s* and the slide-valve *l'* the passage *t*, so that when the valve *l* is raised by the action of the rod *n*, lever *n'*, and finger n^3, as described, the opening and passage l^2 in the said valve connect the gas-inlet *j* and the air-inlet *k* by the passage *s* and inlet *s'* with the charging-cylinder *d'*. When the finger n^3 begins to fall again, the valve *l* is closed by the action of the spring *r*. Similarly, when the finger n^4 raises the valve *l'*, the opening and passage l^2 therein place the gas-inlet *j'* and air-inlet *k* in communication with the passage *t*, and so by the inlet *t'* with the charging-cylinder *d*. When too much gas is being admitted to the engine through lightening of the load or from other cause, and the governor-balls *p* rise, the rod *o'* is raised and draws the rod *o* in the direction of the arrow, Fig. 1, thereby moving the fingers n^3 n^4 clear of the valves *l l'*, so that when the fingers rise by the action of the rod *n* they fail to raise either of the valves *l l'*, and no more gas and air are admitted to the charging-cylinders *d d'* until the governor-balls again fall and the fingers n^3 n^4 resume their vertical position. The power-cylinders *e e'* are furnished with exhaust-ports e^2 e^3, respectively, as shown in Fig. 2 and illustrated, also, by Fig. 5, and the engine is provided with the usual arrangements for storing gas, for supplying flame to the slide ignition-valves *m m'*, and for jacketing the power-cylinders.

The operation of the engine constructed and arranged as above described is as follows: The engine may be started in any convenient manner, either by turning the fly-wheel, or, in the case of large engines, by the application of an auxiliary starting-engine, and as the pistons move in the direction of the arrow, Fig. 1, the traverse of the connecting-rod m^2 operates the rod *n* and raises the valve *l'*, thereby placing the gas-inlet *j'* and air-inlet *k* into communication with the passage *t*, so that as the piston *f* moves outward it draws into the charging-cylinder *d* from the passage *t*, through the inlet *t'*, a charge of mixed gas and air. On the return-stroke the finger n^4 drops and the spring *r'* closes the valve *l'*, thereby shutting off the gas and air supply from the charging-cylinder *d*, while the finger n^3 opens the valve *l* and by means of the passage *s* and inlet *s'* connects the gas and air supply with the charging-cylinder *d'*, so that as the combined pistons *f g* move inward the piston *f* expels the charge from the cylinder *d* through the port *t'* into the passage *t*, while, the combined pistons *f' g'* moving outward, the piston *f'* draws from the supply *j k* a charge of mixed gas and air through the passage *s* and port *s'* into the charging-cylinder *d'*. On the next stroke the pistons again move in the direction of the arrow, Fig. 1, and after the piston *g* has moved a certain distance outward the pressure on the contents of the power-cylinder *e* will be reduced sufficiently to allow the mixture of gas and air in the passage *t* to raise the non-return valves and to rush through the inlet t^2 into the power-cylinder *e*. Meanwhile, as the valve *l'* is at this time open, the charging-piston *f* will be drawing in a fresh charge through the port *t'*, as already described, and the charging-piston *f'* will be expelling the charge from the cylinder *d'* into the passage *s*. On the next stroke the piston *g*, moving inward, compresses into the combustion chamber of the cylinder *e* the charge of mixed gas and air in the said cylinder, the charging-piston *f* expels the charge from the cylinder *d*, the piston *f'* draws in a fresh charge into the charging-cylinder *d'*, and the piston *g'* a mixed charge from the passage *s* through the valves s^3 into the power-cylinder *e'*. The slide ignition-valve *m* then brings the flame to the port in connection with the inlet t^2, thereby igniting the charge compressed within the power-cylinder *e* and giving an impulse to the power-piston *g*, which moves outward, and the power-piston *g'*, moving inward, compresses the mixed charge within the power-cylinder *e'*. When the piston *g'* has reached the limit of its instroke, the compressed charge within the combustion-chamber of the power-cylinder *e'* is exploded by the flame carried by the slide ignition-valve *m'*, and thus an impulse is given to the piston *g'*. During the outstroke of the power-piston *g*, as above described, the exhaust-ports e^2 are uncovered as the said piston approaches the limit of its outstroke, and the new charge admitted to the cylinder *e* from the passage *t* at that moment sweeps out the products of combustion through the exhaust-ports e^2, and, similarly, when the power-piston *g'* uncovers the exhaust-ports e^3, the charge under tension in the passage *s*, rushing through the valves s^3 into the cylinder *e'* sweeps out the products of combustion through the exhaust-ports e^3.

It will be obvious from the foregoing description of the cycle of operations that compressed charges of mixed gas and air are fired first in one power-cylinder and then in the other, and consequently that two impulses are obtained for every revolution of the crank-shaft. When, however, the load is suddenly lightened, or from other causes it is necessary that the engine should develop less power, and the governor *p* by means of the connecting-rods *o o'* moves the fingers n^3 n^4 out of their vertical positions, then the fingers cease to operate the valves *l l'* and the supply of gas and air is cut off from the engine, and no explosion takes place within the power-cylinders until the engine regains its normal speed and the fingers n^3 n^4 have recovered their vertical position.

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

1. The charging-cylinders *d d'*, their pistons *f f'*, the power-cylinders *e e'* and their pistons *g g'*, the piston-connecting rods *i i'*, and crank-

shaft *c*, in combination with the valves *l l'*, controlling-passages *s* and *t*, communicating at one end with the gas and air inlets and at the other end with their respective charging and power cylinders, said valves being operated by suitable connections from one of the connecting-rods of the two slide ignition-valves *m m'* and regulated by connections from the governor *p*, all substantially as and for the purposes herein described.

2. The combination, with the two compound cylinders *d e d' e'*, their respective pistons connected to the crank-shaft *c*, to which are also connected the slide ignition-valves *m m'*, of ports and passages leading from the gas and air inlets to the cylinder, and the valves *l l'*, the fingers n^3 n^4, operated by connections from the connecting-rod m^2, the springs *r r'*, and the connections to the governor, all substantially as herein set forth, for the purposes specified.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 19th day of January, 1888.

HUGH WILLIAMS.

Witnesses:
C. SEDGWICK,
EDGAR TATE.