(No Model.)

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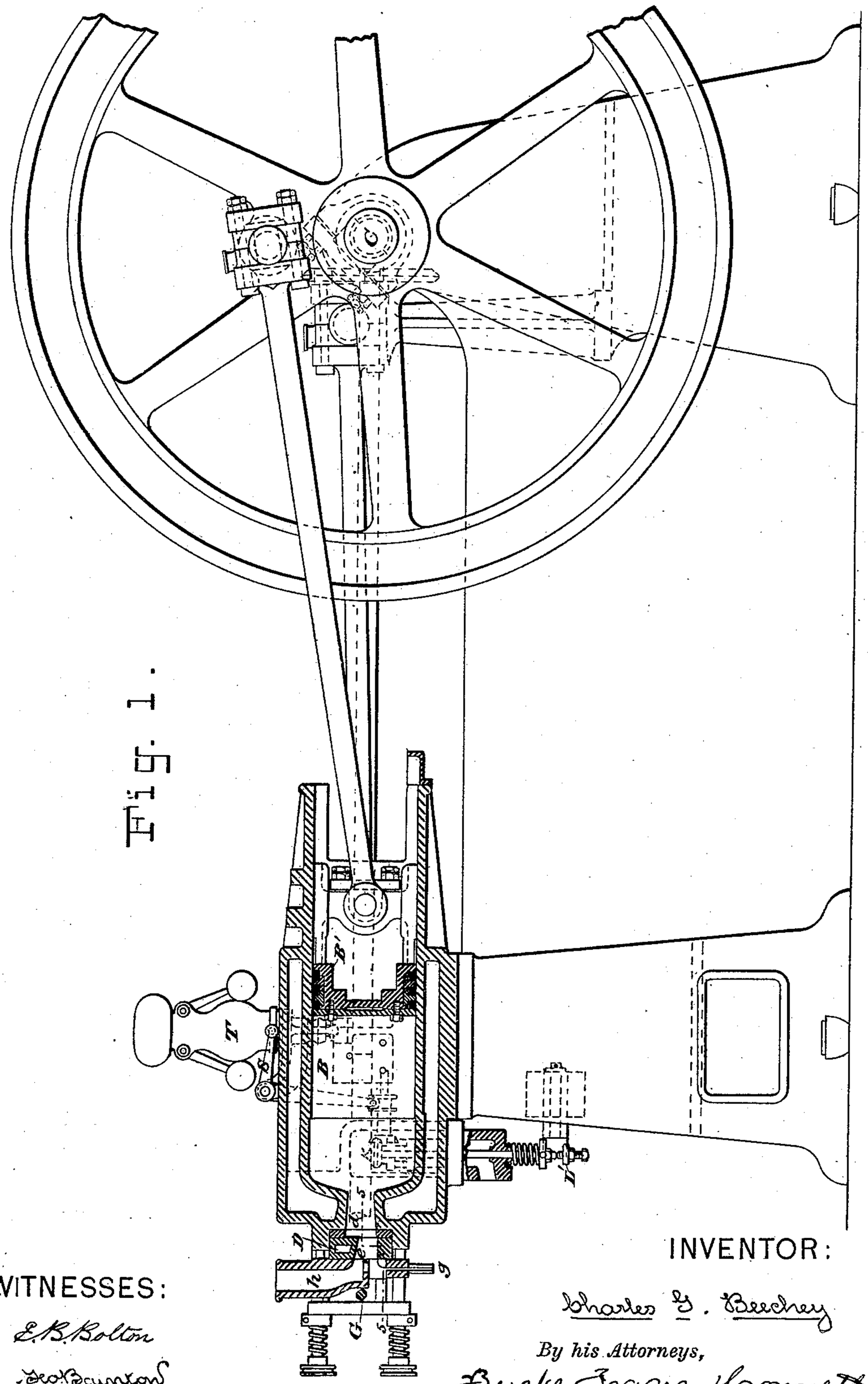
C. G. BEECHEY.

GAS ENGINE.

No. 264,126. Patented Sept. 12, 1882.



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(No Model.) 5 Sheets—Sheet 2.

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GAS ENGINE.

No. 264,126. Patented Sept. 12, 1882.

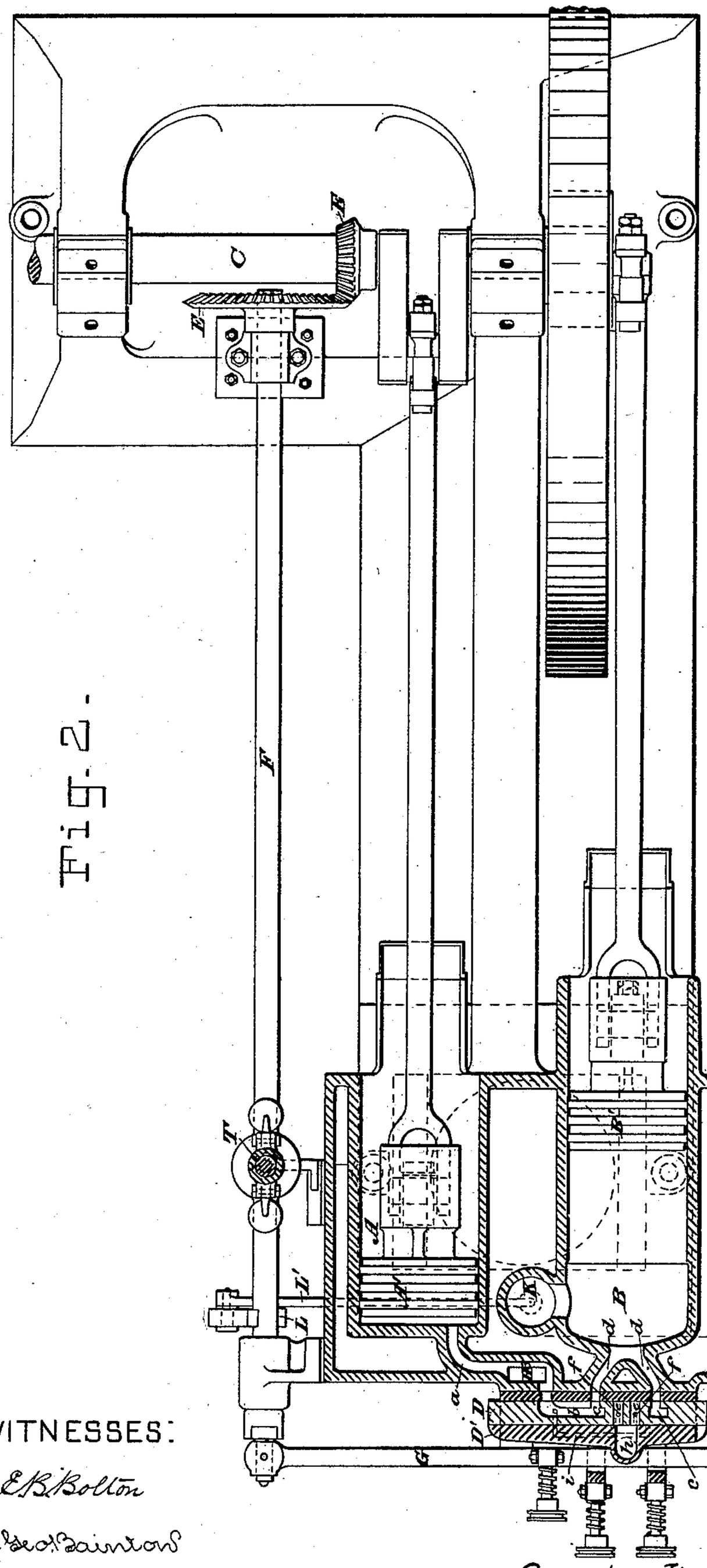

Fig. 2.

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5 Sheets—Sheet 3.

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GAS ENGINE.

No. 264,126.

Patented Sept. 12, 1882.

Fig. 3.

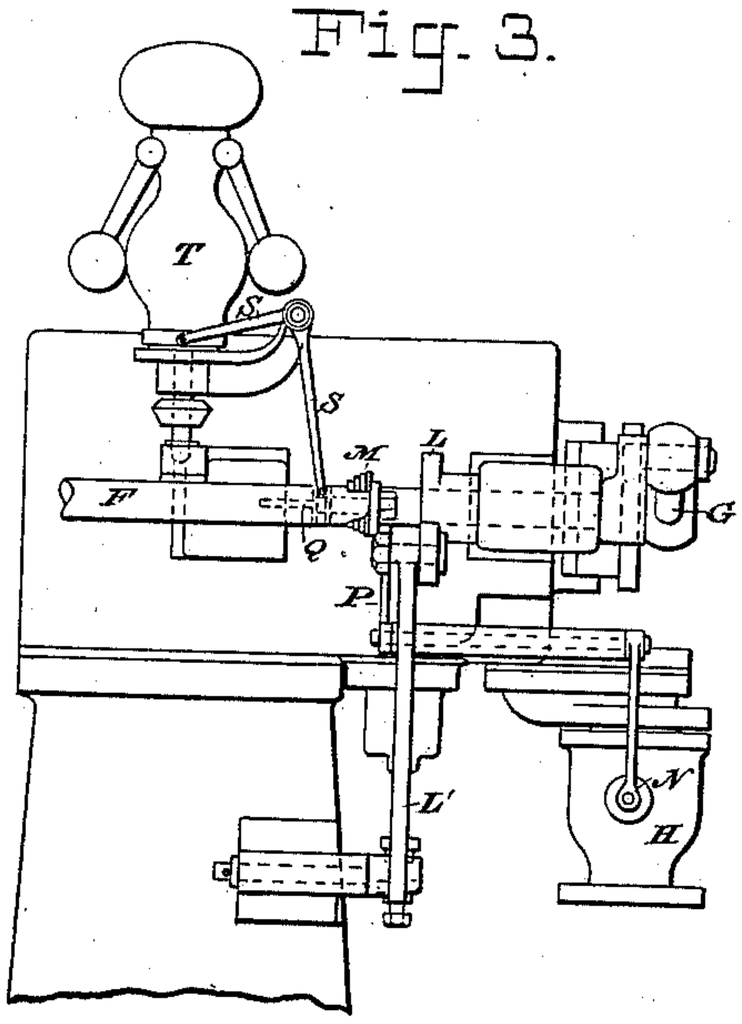


Fig. 4.

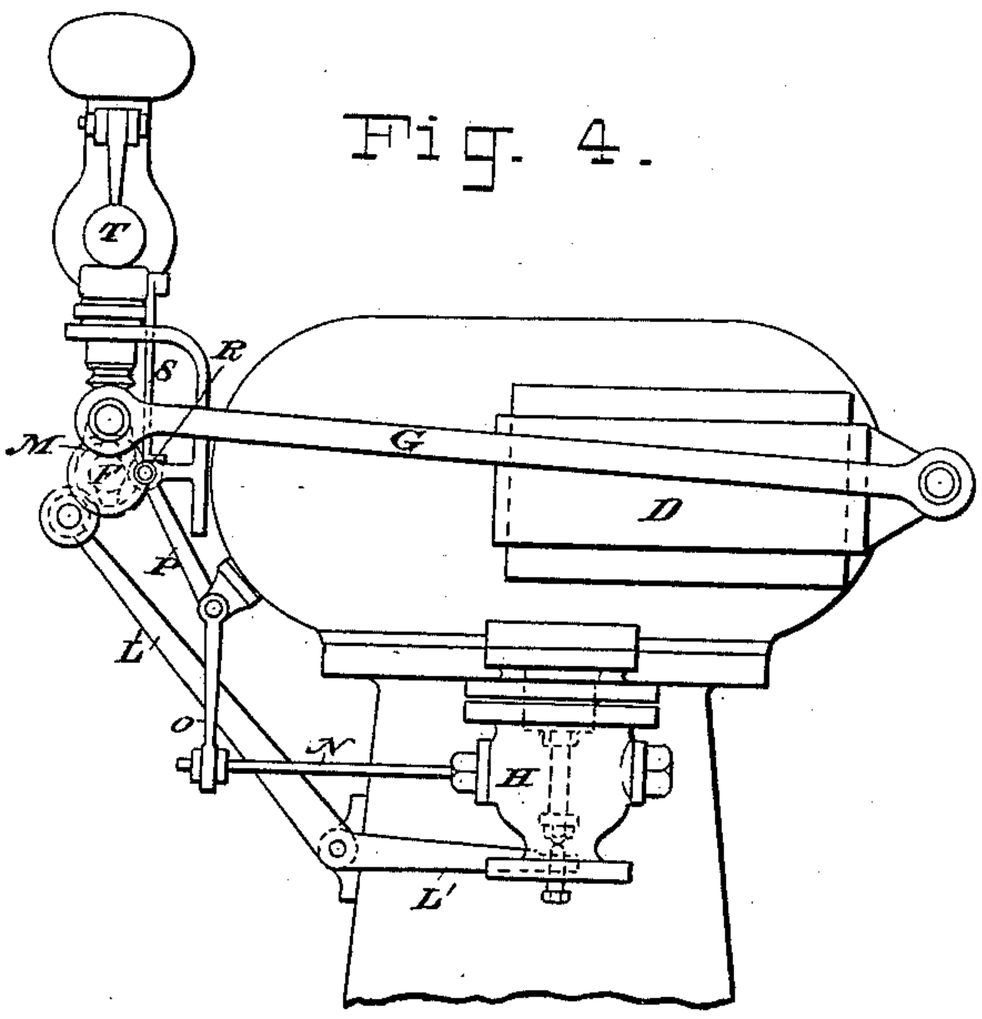
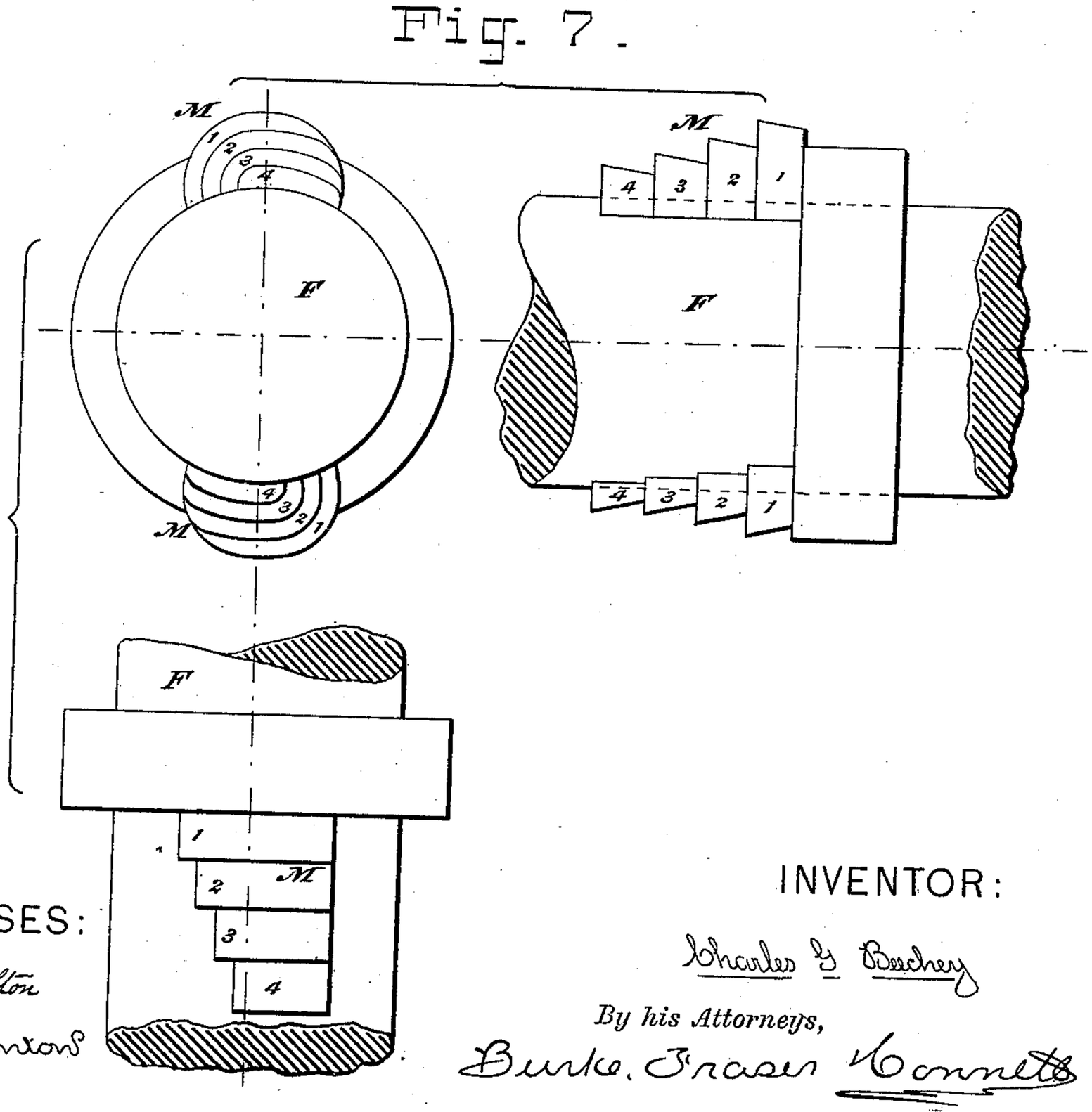


Fig. 7.



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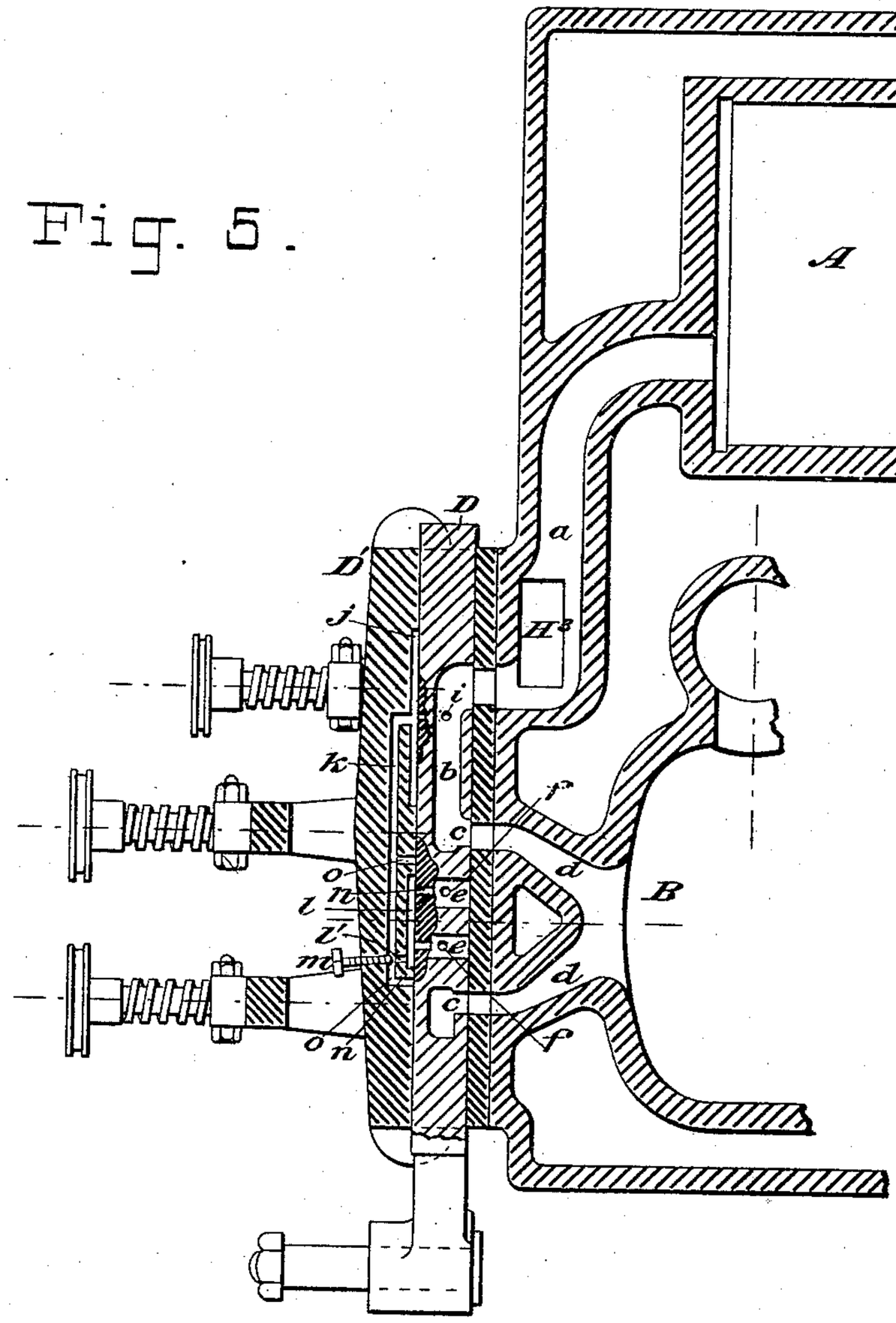
GAS ENGINE.

No. 264,126.

Patented Sept. 12, 1882.

Fig. 5.



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5 Sheets—Sheet 5.

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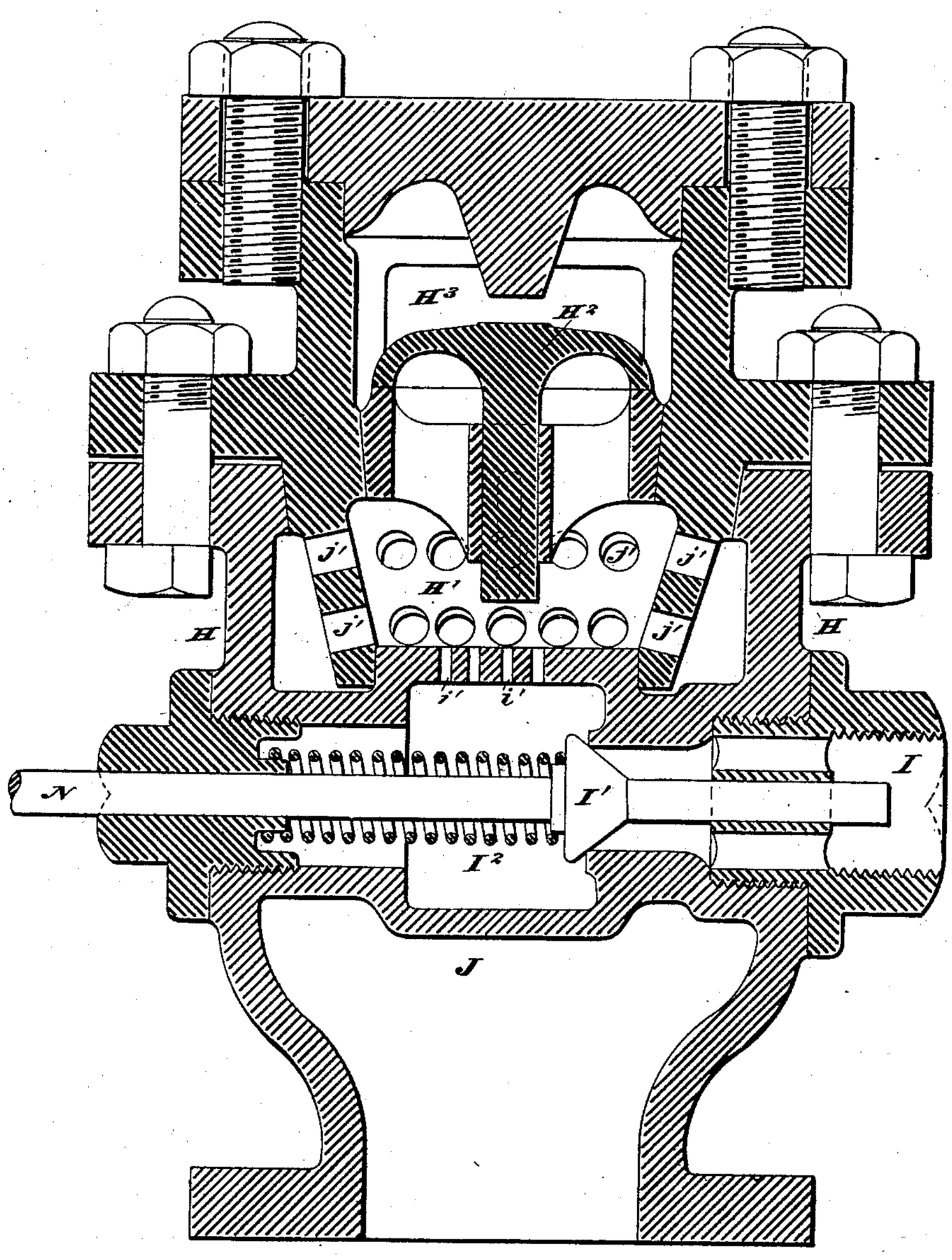
GAS ENGINE.

No. 264,126. Patented Sept. 12, 1882.

Fig. 6.



WITNESSES:

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UNITED STATES PATENT OFFICE.

CHARLES GRANTLEY BEECHEY, OF LIVERPOOL, ENGLAND, ASSIGNOR TO WILLIAM THOMPSON MANN, JAMES GREGSON CHAPMAN, ALF ED CHAPMAN, HENRY SHIELD, AND ALEXANDER SPEIRS, ALL OF SAME PLACE.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 264,126, dated September 12, 1882.

Application filed December 29, 1881. (No model.) Patented in England July 6, 1881, No. 2,961; in France December 22, 1881, No. 134,503, and in Germany December 24, 1881, No. 55,051.

To all whom it may concern:

Be it known that I, CHARLES GRANTLEY BEECHEY, of Liverpool, England, have invented certain Improvements in Gas-Motor Engines, of which the following is a specification.

My invention has reference more particularly to gas-motor engines which have, in addition to the power-cylinder in which the explosion of the gas or gaseous mixture is effected, a second cylinder, into which the gas or gas and air are drawn, in which they are compressed or partly compressed, and from which they are forced into the power-cylinder.

The invention consists in so arranging the cranks of the pistons of the two cylinders relatively to each other and the slide-valve which regulates the admission of the gaseous mixture into the power-cylinder that the charging of the power-cylinder with compressed gaseous mixture is effected during about the last one-tenth part of the return or inward stroke of the power-piston and about the first one-tenth part of the outward stroke of this piston, at which point the explosion takes place. By this arrangement the burnt gases arising from the previous explosion are sufficiently expelled by the power-piston itself in its return-stroke without the use of a scavenging charge of air, the exhaust-valve being open during the first nine-tenths of the said return-stroke, while a sufficient charge of the gaseous mixture is admitted to the power-cylinder in a compressed state, and then almost immediately exploded before the piston therein has proceeded so far on its outward stroke as to prevent the explosion taking full effect.

The invention further consists in closing by means of the said slide-valve communication between the power and compression cylinders after the former cylinder has received its charge, but before the compression-piston has quite completed its return-stroke, so that the exploding-burner, which is supplied from the compression-cylinder, may, by the further compression effected during the completion of the stroke, be supplied with mixture at a greater pressure than that in the power-cylinder, whereby all risk of the exploding-burner being blown back or blown out before the explosion takes place is avoided.

The invention also consists in producing an explosion at every outward stroke of the piston by means of an exploding-burner (or burners) carried in the slide-valve and moving between two ports leading to the power-cylinder, in which ports the explosion takes place alternately, the slide-valve moving at half the time of the power-piston.

The invention also consists in governing the engine by causing an ordinary governor to close the gas-inlet valve to the compression-pump at an earlier or later point of the outward or suction stroke of the compression-piston, and also to regulate the extent of the opening of the said valve, the air-inlet valve remaining fully open during the whole of said stroke, so that a greater or less amount of unmixed air may enter the compression-cylinder behind the mixture of gas and air admitted during the first part of the stroke, and that the amount of air in said mixture itself may be greater or less, whereby when the contents of the compressed cylinder are discharged into the power-cylinder in the reverse order there may a greater or less amount of unmixed air next the power-piston and a correspondingly less or greater amount of mixed gas and air behind the unmixed air, which mixture is also correspondingly weaker or stronger, and thus the power or effect of the explosion will be less or greater.

In the accompanying drawings, Figure 1 is a longitudinal section taken through the center of the power-cylinder, Fig. 2 a horizontal mid-section, Fig. 3 a partial side elevation, and Fig. 4 a rear elevation, of a gas-motor engine constructed according to my invention. Fig. 5 is a horizontal section on the line 5 5 of Fig. 1, showing the gas-passages for supplying the exploding burner or burners. Fig. 6 is a horizontal section, on a larger scale, of the gas and air inlet valve-box. Fig. 7 represents in several views and on a larger scale

the several cam-surfaces through which the opening of the gas-inlet valve is controlled by the governor.

A is the compression-cylinder, and A′ its piston.

B is the power-cylinder, and B′ its piston.

C is the crank-shaft, the cranks of the two pistons A′ and B′ being so placed that the piston A′ follows the piston B′ at a distance equivalent to about thirty degrees of the cranks' travel.

D is the slide-valve. It works at half the time of the piston, and is actuated by the crank-shaft C through the intermediation of the bevel-gearing E E, side shaft, F, and connecting-rod G.

D′ is the valve-cover. (Not shown in Figs. 3 and 4.)

H is the gas and air inlet valve-box.

I is the gas-inlet; I′, the gas-valve; J, the air-inlet; H′, Fig. 6, a chamber in which the gas and air meet and mix, the air entering this chamber through the apertures *j′ j′* and the gas through the apertures *i′ i′*; H², a back-pressure valve; H³, the passage from the valve-box to the compression-cylinder A.

K is the exhaust-valve, worked by a double cam, L, on the side shaft, F, through the intermediation of the rod L′.

M is a double cam, also on the shaft F, and of stepped or tapered form, as shown—that is to say, it is composed of a series of double cam-surfaces, 1 2 3 4, as seen in the detached view, Fig. 7.

R is a runner bearing against the cam M and mounted on a spindle, Q. It is moved backward and forward along this spindle by means of levers S S, which are actuated by the rise and fall of the governor T. The end of the spindle Q is fastened to a lever, P, which, through another lever, O, acts on the spindle N of the gas-valve I′.

a is a passage leading from the cylinder A, so as to communicate at the proper time with the passage *b* in the slide-valve D. This passage *b* has two ports, *c c*, corresponding with two ports, *d d*, leading into the power-cylinder B.

e is a double chamber in the slide-valve, situated midway between the ports *c c* and carrying two exploding-burners, *f*, (or the chamber *e* may be single and carry only one burner, if desired.) When the chamber *e* is in its central position it is in communication with a master-light, *g*, which is always kept burning in or below a pipe or chimney, *h*. The gaseous mixture for the exploding-burners *f* passes from the passage *b* through a port, *i*, into a groove, *j*, in the valve-cover D′, and thence by a passage, *k*, to a groove, *l*, the port *l′* leading to the groove *l* being throttled by a regulating-screw, *m*, so as to allow just enough of the gaseous mixture to keep the burners *f* alight to pass into the groove *l*, and thence by the ports *n* to the burners, so long as the chamber *e* is opposite the master-light *g*; but when by the movement of the valve D the chamber *e* is shut off from the master-light the ports *n* come into communication with one or other of the unthrottled ports *o o*, so that the full force of the gaseous mixture is brought upon the burners *f*, the pressure of said mixture being at the same time increased, as more fully hereinafter described. When there is only a single burner *f* there will be only one port *n*.

Having described the various parts of the engine except such as are of ordinary construction or will be clearly understood, I proceed to explain its action or mode of working.

In the first part of the outward stroke of the compression-piston A′ it draws air by the inlet J (which is always open) and gas by the inlet I, the valve I′ being at this time opened through the action of the cam M. The gas and air thus drawn become mixed in the chamber H′, Fig. 6, and then pass by the back-pressure valve H² and passage H³ to the cylinder A. At a certain point of the outward stroke of the piston, regulated by the position of the governor T, the cam M allows the gas-valve I′ to be closed by means of its spring I², and during the remainder of the stroke only air is drawn in; or, if the engine is going very slow and the runner R is on the largest step, 1, of the cam, as shown in the drawings, the gas-valve I′ is opened during the whole outward stroke of the piston A′; or if, on the other hand, the engine is going much too fast and the governor is quite up, the runner R goes off the cam altogether, and then the gas-valve I′ is not opened at all during the stroke and only air is admitted. In normal working the runner R will be on one of the steps 2, 3, and 4. It will be seen by the form of the cam-surfaces, Fig. 7, that the surface 1, which keeps the gas-valve open longest, also opens it fully; that the next surface, 2, which keeps the valve open for a shorter time, opens it less fully, and so on for the surfaces 3 and 4. The governor therefore not only regulates, according to the speed of the engine, the amount of the mixture of gas and air drawn into the cylinder A before the unmixed air, but also the proportion of gas drawn in with the air, and consequently the strength of the mixture. On the return-stroke of the piston A′ it compresses the contents of the cylinder A during about one-half of the stroke, by which time the power-piston B, which has been moving on its return or exhaust stroke and driving out the burnt gases through the exhaust K, is within about one-tenth of the completion of this stroke. At this moment the exhaust-valve K closes and the slide-valve D opens communication between the two cylinders A and B through the passages and ports *a*, *b*, *c*, *c*, and *d d*, so that the gases are momentarily compressed to the maximum between the two pistons A′ B′—that is to say, until the piston B′ completes its inward stroke and commences to move outward. The communication through the slide-valve D remains open until the pis-

ton A′ has nearly completed its inward stroke and the piston B′ has made nearly one-tenth of its outward stroke, during which time the air and gaseous mixture enter the cylinder B in the reverse order to that in which they previously entered the cylinder A—that is to say, the unmixed air enters the cylinder B in advance of the mixture of gas and air. While the mixture is entering the cylinder B a small proportion of it travels from the passage *b* through the port *i*, groove *j*, passage *k*, port *l′*, groove *l*, and ports *n* to the exploding-burners *f*. After the communication between the cylinders A and B has been cut off, owing to the ports *c c* passing the ports *d d*—that is to say, during the last portion of the inward stroke of the piston A′—the communication between the cylinder A and the exploding-burners *f* is still open, so that these burners are supplied with the gaseous mixture at an increasing pressure due to the further compression exerted by the piston A′, so that the light is not liable to be blown out or back by the inferior pressure in the cylinder B when, through the continued movement of the slide-valve D, the chamber *e* comes opposite one of the ports *d d*. Further, before the chamber *e* comes into communication with the port *d* the ports *n* put the exploding-burners *f* into communication with the corresponding unthrottled port, *o*, in place of the throttled port *l′*, so that the full pressure of the gaseous mixture is brought to bear upon the burners *f*. Immediately upon the chamber *e* coming into communication with the port *d*, at which time the piston A′ has just completed its inward stroke and the piston B′ has made about one-tenth of its outward stroke, the charge is exploded and the piston B′ propelled forward. The exploding-burners *f* are extinguished by the explosion; but are relighted by the master-burner *g* as soon as the chamber *e* comes in communication therewith. It will be understood that, as the slide-valve makes only one stroke to two strokes of the pistons, the explosion is effected through the two ports *d d* alternately; but the charge for every explosion enters the cylinder B through both these ports simultaneously.

What I claim, and desire to secure by Letters Patent, is—

1. In a gas-motor engine having a power or explosion cylinder and a cylinder for preparing and compressing the charge for the explosion-cylinder, the exhaust-valve and the cranks of the pistons of the two cylinders, arranged relatively to each other and the valve which regulates the transfer of the charge from the compression-cylinder direct into the power-cylinder, substantially as described, so that the exhaust-valve remains open during about the first nine-tenths of the return-stroke of the power-piston, and then closes, and that the charging of the power-cylinder with the compressed gaseous mixture is then effected during about the last one-tenth part of the said return-stroke of the power-piston and about the first one-tenth part of the outward stroke of this piston, at which point of the stroke the explosion takes place, substantially as and for the purposes herein set forth.

2. In a gas-motor engine having a power or explosion cylinder and a cylinder for preparing and compressing the charge for the explosion-cylinder, the cranks of the pistons of the two cylinders, arranged relatively to each other and the valve which regulates the transfer of the charge into the power-cylinder and the supply of a portion of the compressed gaseous mixture to the exploding burner or burners, substantially as described, so that the communication between the two cylinders is closed before the compression-piston has quite completed its compression-stroke, and that by the further pressure effected during the completion of the stroke the exploding burner or burners are supplied with gaseous mixture at greater pressure than that in the power-cylinder, substantially as and for the purpose set forth.

3. In a gas-motor engine having a power or explosion cylinder and a cylinder for preparing and compressing the charge for the explosion-cylinder, and in which the slide-valve makes one stroke to two strokes of the power-piston, the two ports *d d*, substantially as described, leading to the power-cylinder, in combination with an exploding burner or burners carried in the slide-valve, which burner or burners move between the said two ports, so that the explosion takes place in said ports alternately, substantially as set forth.

4. In a gas-motor engine having a power or explosion cylinder and a cylinder for preparing and compressing the charge, the gas-inlet valve, closed independently of the air-valve, which remains open during the entire stroke, by means of an ordinary governor at an earlier or later point of the outward stroke of the compression-piston, according to the speed of the engine, substantially as described, so that a greater or less amount of unmixed air is drawn into the compression-cylinder behind a correspondingly less or greater amount of mixture of gas and air, substantially as and for the purpose set forth.

5. In a gas-motor engine having a power or explosion cylinder and a cylinder for preparing and compressing the charge, the gas-inlet valve opened independently of the air-valve, which remains open during the entire stroke, more or less fully, by means of an ordinary governor during the outward stroke or the first part of the outward stroke of the compression-piston, according to the speed of the engine, substantially as described, so that a greater or less amount of gas is mixed with air entering through the air-inlet before the mixture of gas and air is drawn into the compression-cylinder, and the strength of the mixture thereby regulated, substantially as and for the purpose set forth.

6. In a gas-motor engine having a power or explosion cylinder and a cylinder for prepar-

ing and compressing the charge, the gas-inlet valve, opened more or less fully by means of an ordinary governor during the first part of the outward stroke of the compression-piston, and closed independently of the air-valve, which remains open during the entire stroke, by means of said governor at an earlier or later portion of said outward stroke of the compression-piston, substantially as and for the purpose set forth.

7. In combination with the cylinders A B, pistons A′ B′, and slide-valve D, arranged and operating as described, the port *i*, groove *j*, passage *k*, groove *l*, port *l′*, and ports *n*, leading to the exploding-burners *f*, said port *i* being in communication with the gas-passage *a* after the communication between said passage and the ports *d d* has been shut off, substantially as and for the purpose set forth.

8. In combination with the cylinders A B, pistons A′ B′, and slide-valve D, arranged and operating as described, and with the port *i*, groove *j*, passage *k*, groove *l*, throttled port *l′*, and ports *n*, leading to the exploding-burners *f* and the unthrottled ports *o o*, substantially as and for the purpose set forth.

9. The combination, substantially as described and shown, of the cylinders A B, pistons A′ B′, slide-valve D, passages *a b*, ports *c c d d*, chamber *e*, exploding-lights *f*, master-lights *g*, port *i*, groove *j*, passage *k*, port *l′*, regulating-screw *m*, groove *l*, ports *n*, and ports *o o*, all arranged and acting relatively to each other in the manner and for the purposes set forth.

10. In combination with the cylinders A B and pistons A′ B′, arranged and working as described, the valve-box H, provided with gas and air inlets I and J, gas-valve I′, mixing-chamber H′, back-pressure valve H^2, and passage H^3, all arranged and acting substantially as set forth and shown.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CHARLES GRANTLEY BEECHEY.

Witnesses:

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SAMUEL CORFE,
Clerk to J. W. Baker, *Notary*, *Liverpool.*