(No Model.) 3 Sheets—Sheet 1.

C. H. ANDREW & H. WILLIAMS.

GAS ENGINE.

No. 341,538. Patented May 11, 1886.

Fig 1.

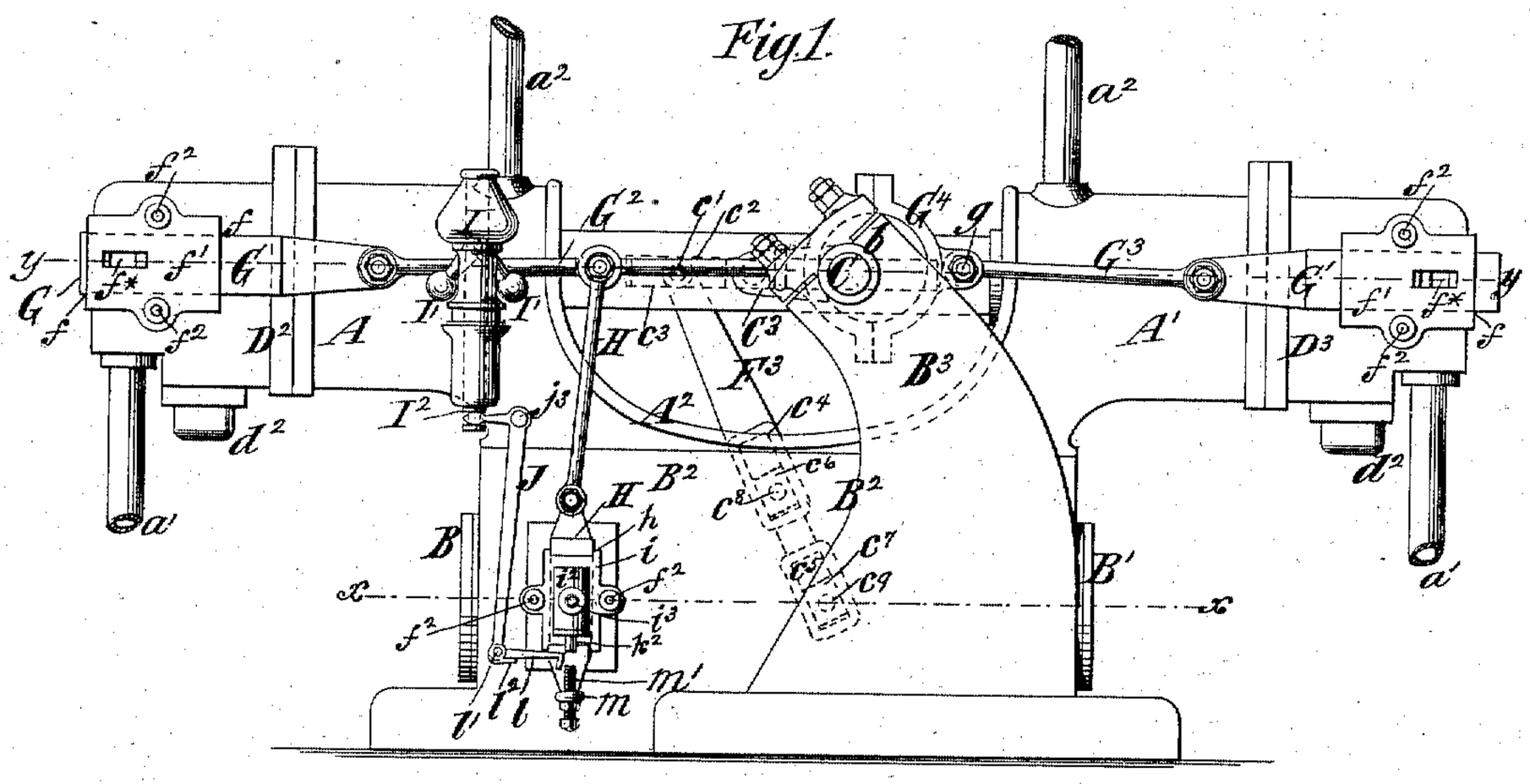

Fig 2.

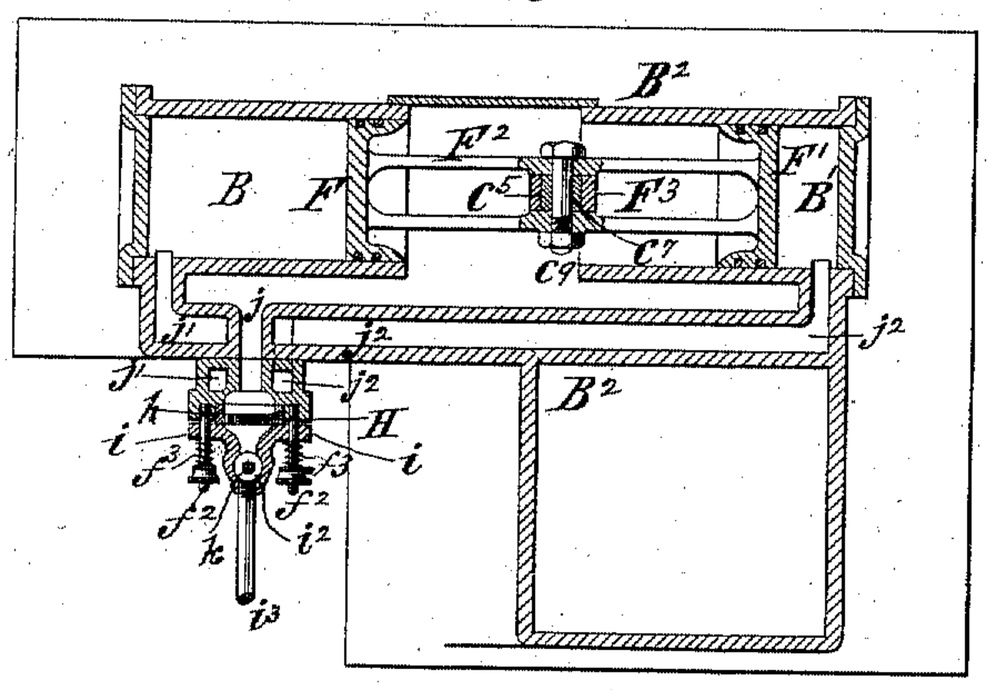

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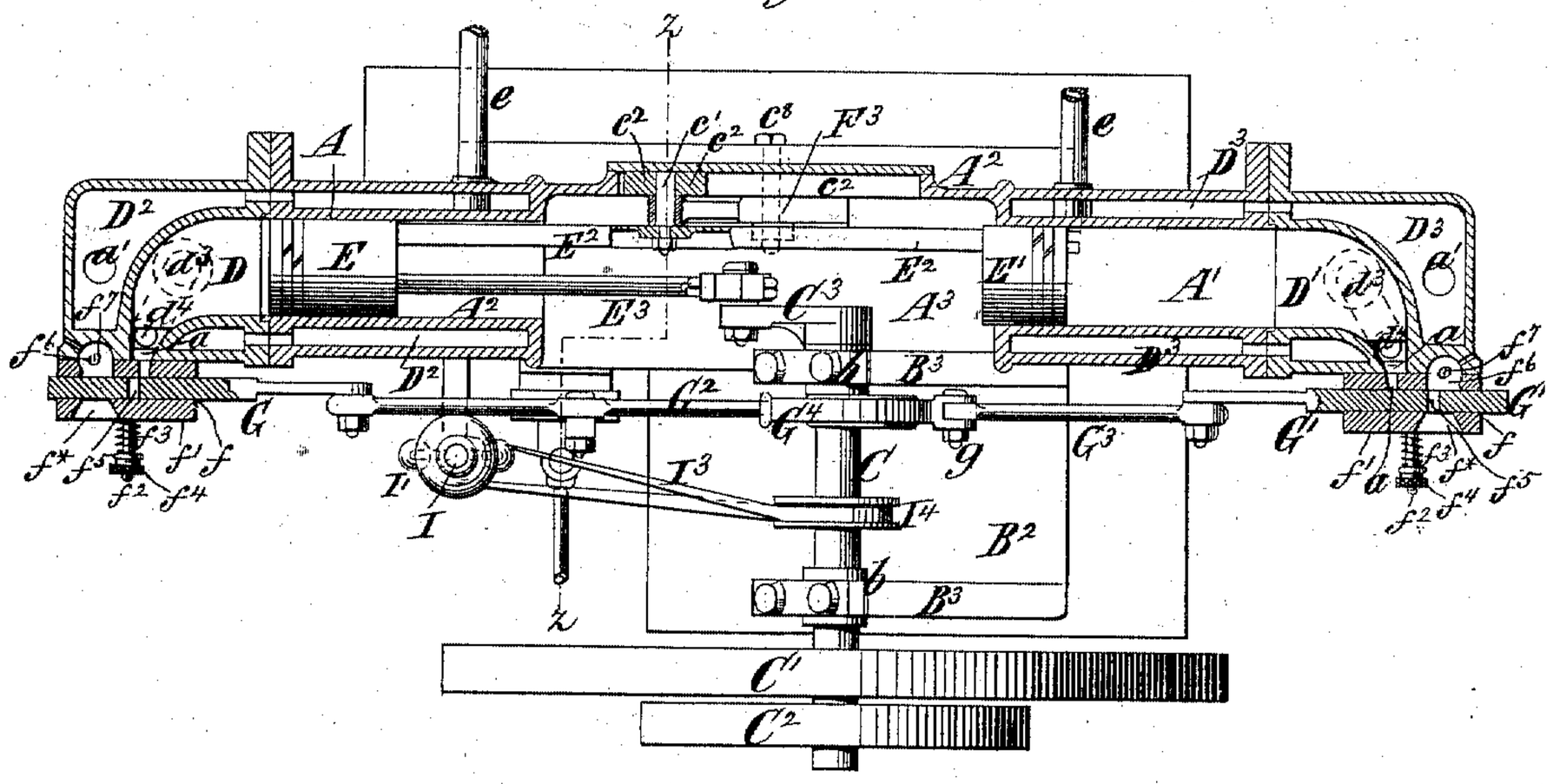
Fig 3.



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(No Model.) 3 Sheets—Sheet 3.

C. H. ANDREW & H. WILLIAMS.

GAS ENGINE.

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Fig. 1.

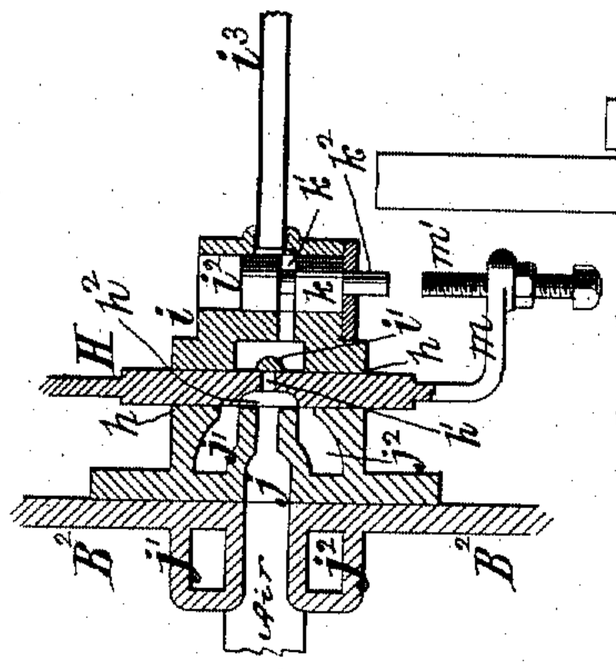


Fig. 5.

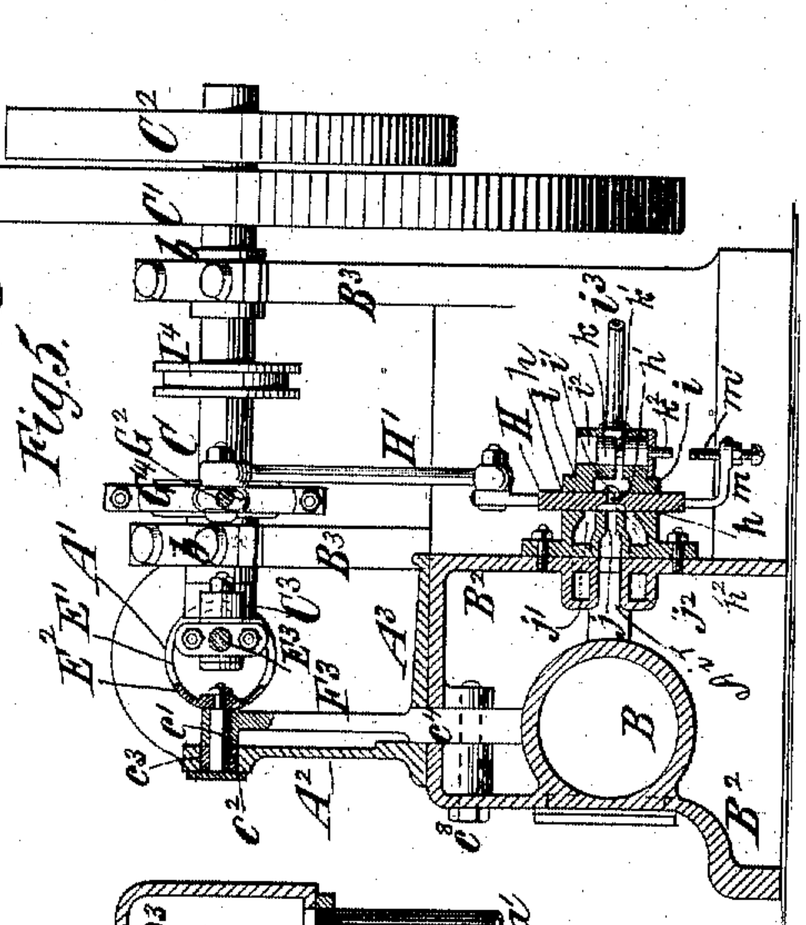


Fig. 6.

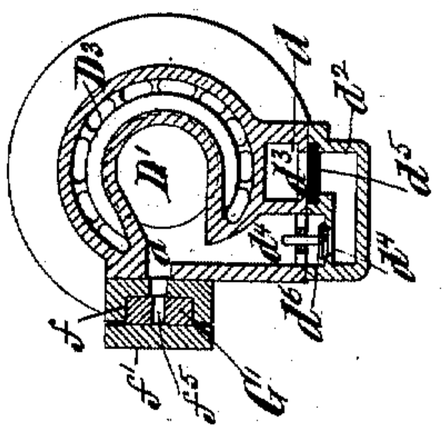
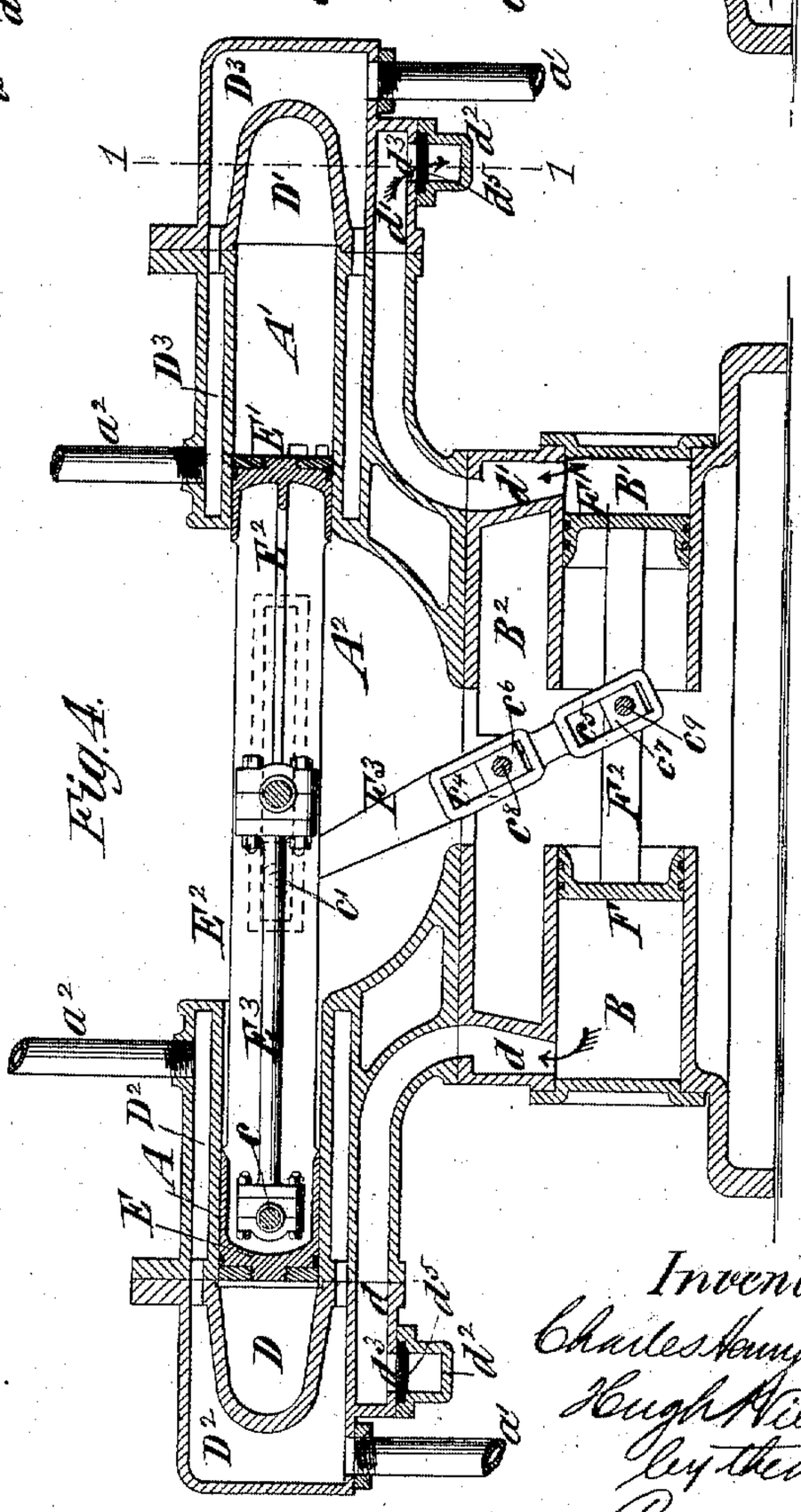


Fig. 4.



Witnesses.
Emil Horter.
Fred K. Haynes

Inventors.
Charles Henry Andrew
Hugh Williams
by their Attys
Brown & Hall

UNITED STATES PATENT OFFICE.

CHARLES HENRY ANDREW AND HUGH WILLIAMS, OF STOCKPORT, COUNTY OF CHESTER, ENGLAND.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 341,538, dated May 11, 1886.

Application filed July 6, 1885. Serial No. 170,683. (No model.)

To all whom it may concern:

Be it known that we, CHARLES HENRY ANDREW and HUGH WILLIAMS, both of Stockport, in the county of Chester, England, have invented a certain new and useful Improvement in Gas-Engines, of which the folowing is a specification.

Our invention relates to that class of engines which are operated by an explosive mixture of gas and air, and which comprise, in connection with each power cylinder and piston, a charging cylinder and piston, and examples of such an engine are shown in United States Letters Patent No. 301,078, granted July 1, 1884, to Charles Henry Andrew, and Letters Patent No. 314,284, granted March 24, 1885, to the same inventor.

In the operation of engines of this class as ordinarily constructed, the charging-piston moves simultaneously with but in an opposite direction to its power-piston, and at each outward stroke of the power-piston, which is effected by the explosion of the compressed mixture of gas and air, a fresh charge of explosive mixture is passed from the charging-cylinder to the power-cylinder, and serves to displace therefrom the waste gases resulting from the previous explosion, while the inward stroke of the power-piston serves to compress such fresh charge of explosive mixture within the combustion-chamber at the end of the power-cylinder, and preparatory to its ignition in that chamber when the power-piston reaches the inner termination of its stroke.

From the above description it will be understood that in this class of engines the power-piston has an operative stroke in one direction only, and an important object of our invention is to provide an engine wherein the crank-shaft and fly-wheel will receive two impulses at each revolution instead of one, as heretofore.

In carrying out our invention we arrange two power-cylinders in line facing each other, and in which work two connected power-pistons, which, by a connecting-rod, operate the crank, and we also arrange two charging-cylders in line facing each other, and in said charging-cylinders work two connected charging-pistons, which, by a lever or other suitable connection, receive motion from the power-pistons.

In engines of the class to which our invension relates, slide-valves, operated by an eccentric, have been employed to control the ignition of the explosive mixture within the combustion-chamber by an ignition-flame burning within an ignition pocket or cavity, and a somewhat similar valve has been employed for controlling the admission of gas and air to the charging-cylinder, for the purpose of obtaining the proper relative proportion of gas and air; and in order to provide for maintaining a uniform speed of the engine a governor has been employed which operates, in connection with a valve independent of the slide-valve controlling the charging-cylinders, for the purpose of increasing or diminishing the quantity of gas taken into the charging-cylinder as the speed of the engine may fall below or rise above the uniform speed which it is desired to maintain.

Our invention also relates to means employed for operating the valve, whereby the admission of air and gas to the charging-cylinder or the two charging-cylinders is controlled, and to the mechanism whereby the governor acts upon an independent gas-valve for increasing or diminishing the quantity of gas admitted for mixture with a determined and uniform quantity of air.

The invention consists in novel combinations of parts, which are hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of an engine embodying our invention. Fig. 2 is a longitudinal horizontal section upon the plane of the dotted line *x x*, Fig. 1. Fig. 3 is a similar horizontal section upon the plane of the dotted line *y y*, Fig. 1. Fig. 4 is a vertical longitudinal section of the engine. Fig. 5 is a transverse vertical section of an engine upon the plane of the dotted line *z z*, Fig. 3. Fig. 6 is a transverse section upon the plane of the dotted line 1 1, Fig. 4, which passes through the combustion-chamber and the jacket inclosing said chamber and the cylinder, and also through a portion of the passage and apertures, whereby the charging-cylinder and power-cylinder are connected; and Fig. 7 is a

detailed sectional view hereinafter described, and upon a larger scale.

Similar letters of reference designate corresponding parts in all the figures.

A A′ designate two power-cylinders, which are arranged in line facing one another, and are here represented as connected by a brace or stretcher, A^2, cast integral with them.

B B′ designate two charging-cylinders, which are also arranged in line facing each other, and are here represented as below the power-cylinders A A′. These charging-cylinders are, as here shown, cast integral with the bed plate or frame B^2, and the connecting-brace A^2, between the power-cylinders, is formed with a broad horizontal foot or flange, A^3, whereby the two power-cylinders are firmly secured upon the bed-plate B^2. The bed-plate B^2 is likewise constructed with two upwardly-projecting standards or portions, B^3, in which are formed or held bearings *b* for the crank-shaft C, which, as here shown, is provided with a fly-wheel, C′, and a pulley, C^2, from which power may be transmitted by a belt. (Not here shown.)

At their outer ends the two power-cylinders A A′ are in free and open communication with the two combustion-chambers D D′, having their inlet-throats *a* presented in a horizontal direction and at the side of the cylinders. Both the power-cylinders A A′ and the combustion-chambers D D′ are surrounded by jackets D^2 D^3, to which cold water or other cooling agent may be supplied by pipes *a′*, and from which the water or other cooling agent may be discharged by pipes h^2, as best shown in Fig. 4.

To the power-cylinders A A′ are fitted two power-pistons, E E′, which are connected by a brace or tie, E^2, made in the same casting with the piston-bodies, and motion is imparted from the power-piston by a connecting-rod, E^3, which is connected with a wrist, *c*, in the piston E, and with the crank-pin of the crank C^3 on the crank-shaft C; consequently it will be understood that the two power-pistons E E′ move simultaneously, each performing its outward stroke, while the opposite piston performs its inward stroke.

In the oppositely-arranged charging-cylinders B B′ are fitted charging-pistons F F′, which are connected by a rod, F^2, and motion is transmitted from the power-pistons to the charging pistons by a lever, F^3, which is best represented in Figs. 3, 4 and 5, but also in Fig. 1. The upper end of the lever F^3 is pivoted on a pin, *c′*, inserted in a slide or sliding block, c^2, and secured fast in the brace or connection E^2, between the two power-pistons E E′. The block or slide c^2 is fitted to a slideway, c^3, which is formed in the brace or connection A^2, between the power-cylinder, as best shown in Fig. 3. The lever F^3 is slotted or yoked at c^4 c^5, so as to receive slides or blocks c^6 c^7, the former of which is supported by and free to turn upon a pin, c^8, fast in the bed-plate B^2, and the latter of which, c^7, is carried by a pin, c^9, projecting from the rod F^2, connecting the two charging-pistons.

As the two power-pistons E E′ are moved backward and forward, they impart a simultaneous movement to the two charging-pistons F F′ in a reverse direction to that in which the power-pistons are moving, the lever F^3 sliding freely upon the blocks c^6 c^7, in order to compensate for the varying distance between the pins or pivots *c′* c^9 and the fulcrum-pin or pivot c^8.

Extending from the outer ends of the two charging-cylinders B B′, and formed partly in the power-cylinder structure and partly in the base or bed plate B^2, are passages *d d′*, through which the explosive mixture of air and gas is discharged from the charging-cylinders to the power-cylinders, and below each cylinder structure is bolted a chest or passage, d^2, which covers apertures or openings d^3 d^4 in the cylinder structure, whereby communication is established between the passages *d d′* and the combustion-chambers D D′. The apertures d^3, which are covered by the chests or channels d^2, have secured over them wire-gauze or analogous material, d^5, forming fine meshes, and the explosive mixture of air and gas in passing through either passage *d* or *d′* from either charging-cylinder must pass through the opening or aperture d^3, which is shielded by the wire-gauze d^5, in order to reach the combustion-chamber D or D′. By the passage of the air and gas through the wire-gauze d^5 they become more uniformly mixed and afford better results when exploded.

Extending from the power-cylinders near their ends, which are open, are exhaust-pipes *e*, and each power-piston E or E′, at the termination of its outward stroke, passes just beyond the exhaust-pipe *e*, and allows the free exhaust of waste gases from behind the piston to said exhaust-pipe. The return of the explosive mixture through the opening d^4 is prevented by a check-valve, d^6, applied thereto, as shown in Fig. 6.

The ignition of the explosive mixture within the combustion-chambers D D′ is controlled by sliding valves G G′, which are fitted to slideways *f*, closed by plates or covers *f′*, which are held in place by bolts f^2, having springs f^3, arranged between said plates and nuts f^4 upon said bolts.

In each valve G G′ is formed a passage, f^5, which by the reciprocation of the valve is alternately brought into communication with the throat *a*, leading from the combustion-chamber and the ignition pocket or cavity f^6, wherein is an ignition or master burner, f^7, which is supplied with gas, and to which is admitted air to support combustion by a passage leading into the said ignition pocket or cavity. When the valve G or G′ is moved in a direction to bring the passage or chamber f^5 opposite the ignition-pocket f^6, such chamber is filled with the explosive mixture, which it has received through the throat *a* from the

combustion-chamber D or D′, and when the chamber or opening f^5 in the valve is brought opposite the ignition-pocket f^6 the gas therein is ignited, and upon the return movement of the valve serves to ignite the explosive mixture within the combustion-chamber D or D′. The plate or valve-chest cover f' has in it an aperture, f^*, which is opposite the ignition-pocket f^6, and serves to ventilate the chamber or valve-passage f^5, to free it from foul gases.

In the position which the parts occupy at the left-hand side of Fig. 3 the explosive mixture in the combustion-chamber D is just about to be exploded, and when this is done the pressure thereby produced will force the piston E outward and produce its working-stroke. When the power-piston has completed its outward stroke, it comes to the position shown at the right hand of Fig. 3, just beyond the exhaust-pipe *e*, so as to permit the free exhaust of the waste gases through the exhaust-pipe, and the charging-piston F′ has at this time completed its inward stroke and discharged its capacity of the explosive mixture into the power-cylinder A′. During the inward movement or stroke of the piston E′ the explosive mixture within the cylinder A′ and chamber D′ are compressed into the combustion-chamber D′, and are there ignited by the valve G′, to produce a return movement of the power-pistons; hence it will be seen that the power-pistons, being arranged in line and connected, transmit to the crank-shaft C two impulses during each revolution, and so tend to produce the running of the engine at a uniform speed.

The two valves G G′, as here shown, are operated by eccentric-rods G^2 G^3, extending from a single strap, G^4, the rod G^3 being jointed to the strap at *g*, in order that such mechanism may be operative.

The admission of air and gas to the charging-cylinders B B′ is controlled by a slide-valve, H, which is reciprocated by a rod, H′, connecting it with the eccentric-rod G^2. This valve works within a chest, *h*, having a covering-plate, *i*, held to its place by springs and bolts f^2 f^3, like those shown for holding the valve-chest covers f' in place. The valve-chest *h* is constructed with an air-inlet passage, *j*, and with passages j' j^2, which lead, respectively, to the outer ends of the charging-cylinder B B′, as best shown in Figs. 2 and 5. The cover *i* of the valve-chest is constructed with a cross bar or portion, i', and the valve H has a line or series of apertures, h', as shown in Fig. 2, which work under and are alternately exposed on the opposite sides of this cross-bar, and on the inner face of the valve is a cove or cavity, h^2, whereby the passages j' j^2 are placed alternately in communication with the air-inlet passage *j*. The construction of the valve and chest, with its ports and openings, is best shown in Fig. 7, but on a smaller scale in Fig. 5.

The valve H is shown in Figs. 5 and 7 as about in central position, and as the valve is moved upward from that position its cove h^2 will first place the air-inlet *j* in communication with the passage j', thereby admitting air to the cylinder B, and during the latter part of the upward movement of the valve gas will be admitted through the holes h' in the valve, and and through the passage j' to the charging-cylinder B. By this valve a larger quantity of air than gas is taken in with each charging of the cylinder, in order to supply the air and gas in proper proportions, and to make the mixture most effective and economical. The valve-chest cover *i* is also formed with a cylindric bore, i^2, wherein is fitted an independent gas-valve, *k*, here shown as in the form of a piston having an annular groove, *k*′, between its ends, and a downwardly-extending stem, k^2. Gas is admitted from any suitable source through a pipe, i^3, to the valve-chest i^2, and when the portion of reduced diameter of the valve *k* is opposite the pipe i^3 the gas is admitted in largest quantity, and by raising the valve the quantity of gas passing from the pipe i^3 will be more or less reduced.

I designates a governor, the balls I′ of which operate on the spindles I^2 in a well-understood manner, the governor being driven by a belt, I^3, from a pulley, I^4, on the crank-shaft C.

J designates a bell-crank lever, which is fulcrumed at j^3 and one arm of which engages with the governor-spindle I^2, while the other and longer arm carries a trip-piece, *l*, which is pivoted at *l*′ to said bell-crank lever. This trip-piece *l* is free to rise, but is prevented from falling below a horizontal position by a toe or stop, l^2, extending from the bell-crank lever J under said trip-piece.

The valve H has a downwardly-projecting arm, *m*, wherein is detachably secured a screw, *m*′, which forms a tappet or pin moving upward or downward with the valve as it travels, and which is directly below or in line with the stem k^2 of the independent gas-valve *k*. The screw *m*′ is so adjusted that at the upward movement of the valve it will not come into direct contact with the valve-stem k^2; but if by the operation of the bell-crank lever J the trip is moved inward between the point of the screw *m*′ and the valve-stem k^2 the valve H will at its next upward movement raise the trip-piece and the valve *k*, and cut off the supply of gas entering through the pipe i^3.

When the speed of the engine exceeds its desired limit, the bell-crank lever J and the trip-piece *l* attached will occupy the position shown in Fig. 1, and thereby permit the valve *k* to fall to the position shown in Fig. 7. The flow of gas is then cut off from the charging-cylinders; but when the engine is running at its normal speed by the depression of the governor-balls the lower arm of the bell-crank lever J is thrown outwardly from the line of the axis of the governor, and the trip-piece *l* is brought to interpose between the tappet-screw *m*′ and the stem k^2 of the gas-valve, and by the upward movement of the slide-valve H the gas-valve *k* will be raised to a position above

that shown in the drawings, and thereby open a constant passage for the flow of gas while running at its normal speed.

It will be obvious that, if desired, two other power-cylinders might be arranged opposite each other and in line by the side of the two power-cylinders here shown and connected with the same crank-shaft, the two cranks being set at right-angles to each other, if desired, and the fly-wheel being arranged centrally between the two pairs of power-cylinders. Each pair of oppositely-arranged power-cylinders would then have its pair of oppositely-arranged charging-cylinders, and the mechanism would all be duplicated for each engine.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. The combination, in a gas-engine, of two power-cylinders arranged in line with each other, two connected power-pistons working in said cylinders, two charging-cylinders and two connected charging-pistons working therein, and connections, substantially as herein described, between the said power-pistons and the said charging-pistons, for the purpose herein specified.

2. The combination of the power-pistons, the charging-pistons, the connecting-rod, the crank-shaft and crank, and the lever connecting the power-pistons and the charging-pistons, substantially as herein set forth.

3. The combination, with the ignition-valve and the eccentric-rod for operating the same, of the charging-valve working transversely to the ignition-valve and the connection between the latter valve and the said eccentric-rod, substantially as herein set forth.

4. The combination, with the governor and the charging-valve and a cut-off, of a pin or tappet provided on the said valve and a piece connected with the governor, to be interposed and withdrawn from between the said tappet and the cut-off, substantially as and for the purpose herein described.

CHARLES HENRY ANDREW.
HUGH WILLIAMS.

Witnesses to the signature of Hugh Williams:

HENRY T. BROWN,
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Witnesses to the signature of Charles Henry Andrew:

WM. HALLIWELL,
WM. SYKES.

Correction in Letters Patent No. 341,538.

It is hereby certified that in Letters Patent No. 341,538, granted May 11, 1886, upon the application of Charles Henry Andrew and Hugh Williams, of Stockport, County of Chester, England, for an improvement in "Gas Engines," an error appears in the printed specification requiring the following correction, viz: In line 36, page 2, the reference letter "h^2" should read a^2; and that the Letters Patent should be read with this correction therein to make it conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 18th day of May, A. D. 1886.

[SEAL.]

H. L. MULDROW,
Acting Secretary of the Interior.

Countersigned:
M. V. MONTGOMERY,
Commissioner of Patents.