(No Model.)

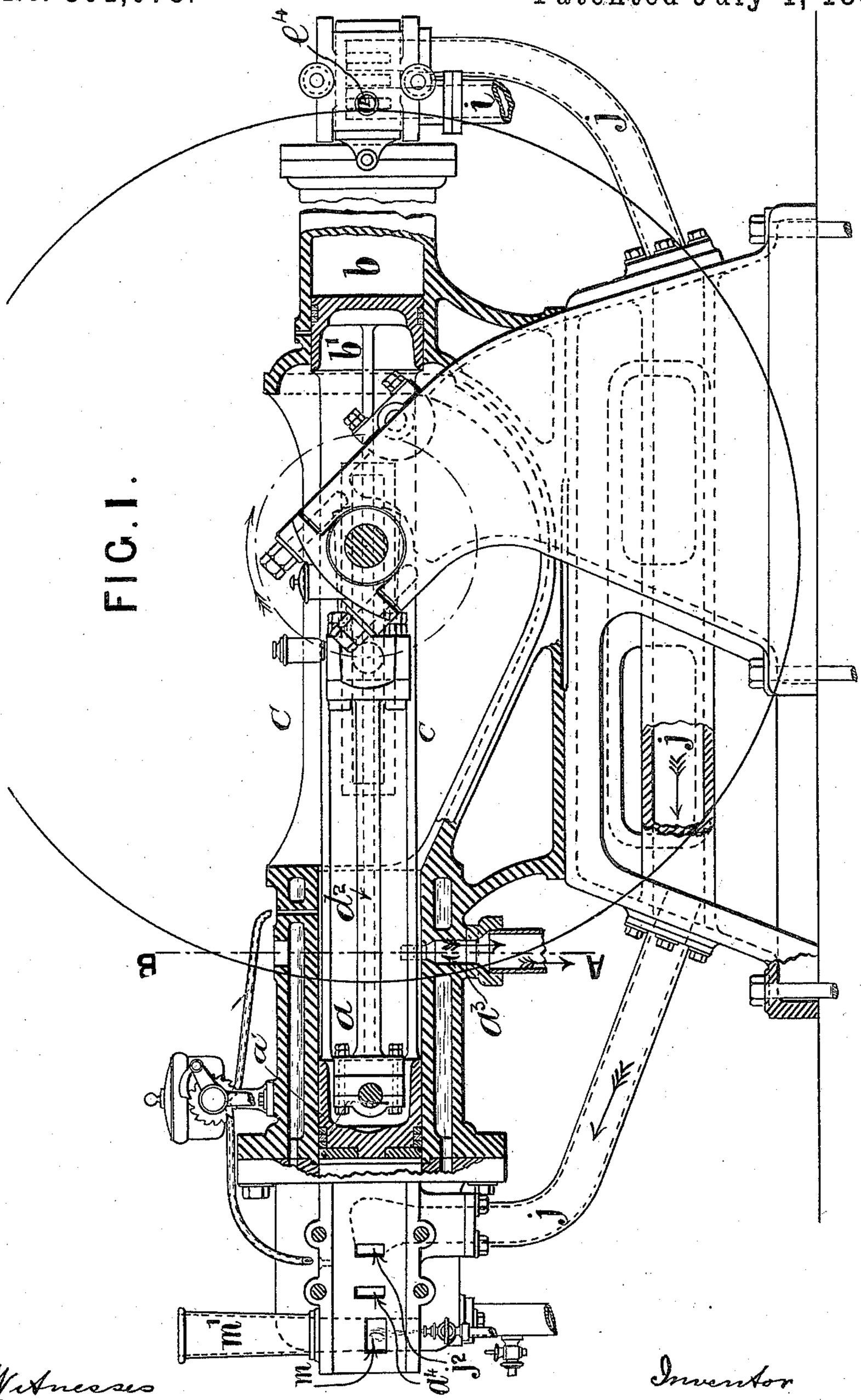
4 Sheets—Sheet 1.

C. H. ANDREW.

GAS MOTOR ENGINE.

No. 301,078. Patented July 1, 1884.

FIG. 1.



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(No Model.) 4 Sheets—Sheet 2.

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FIG. 2.

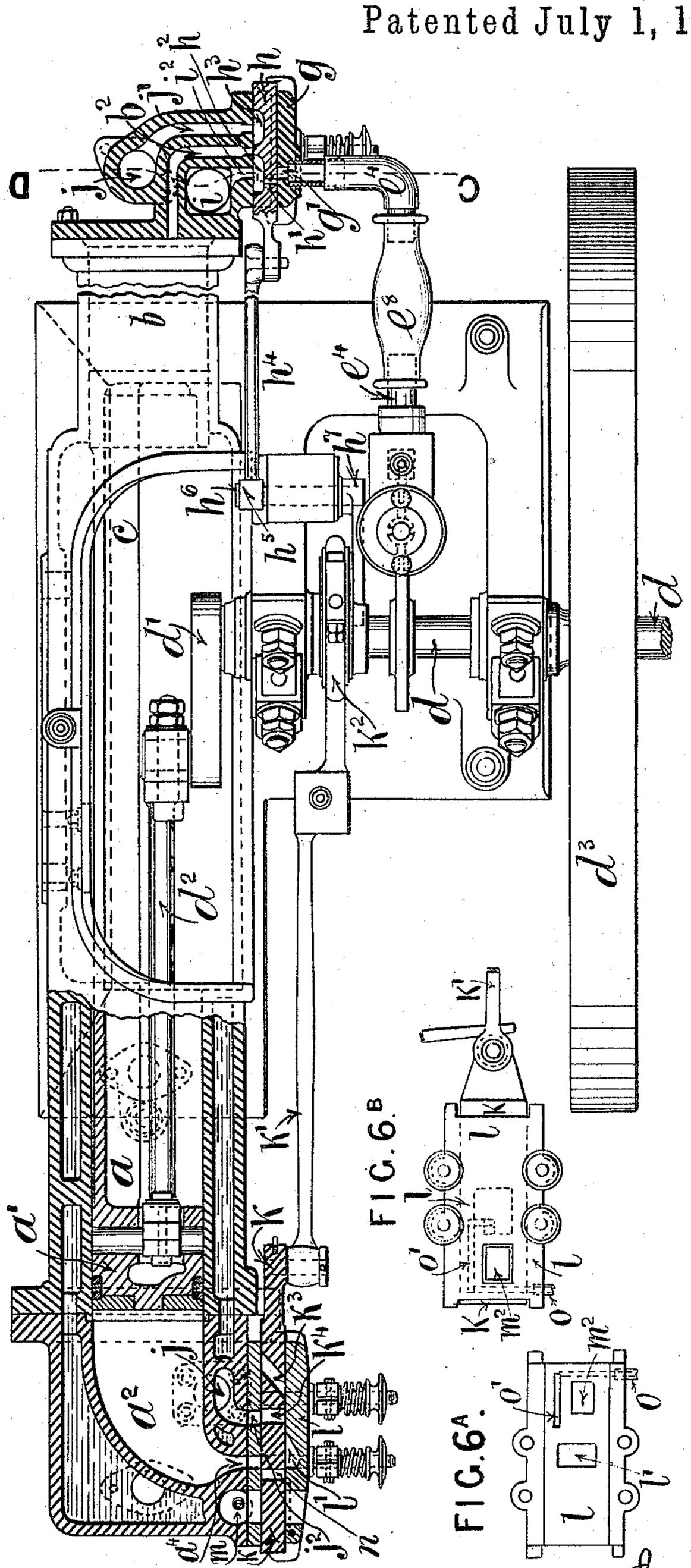

FIG. 6B.

FIG. 6A.

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FIG. 4.

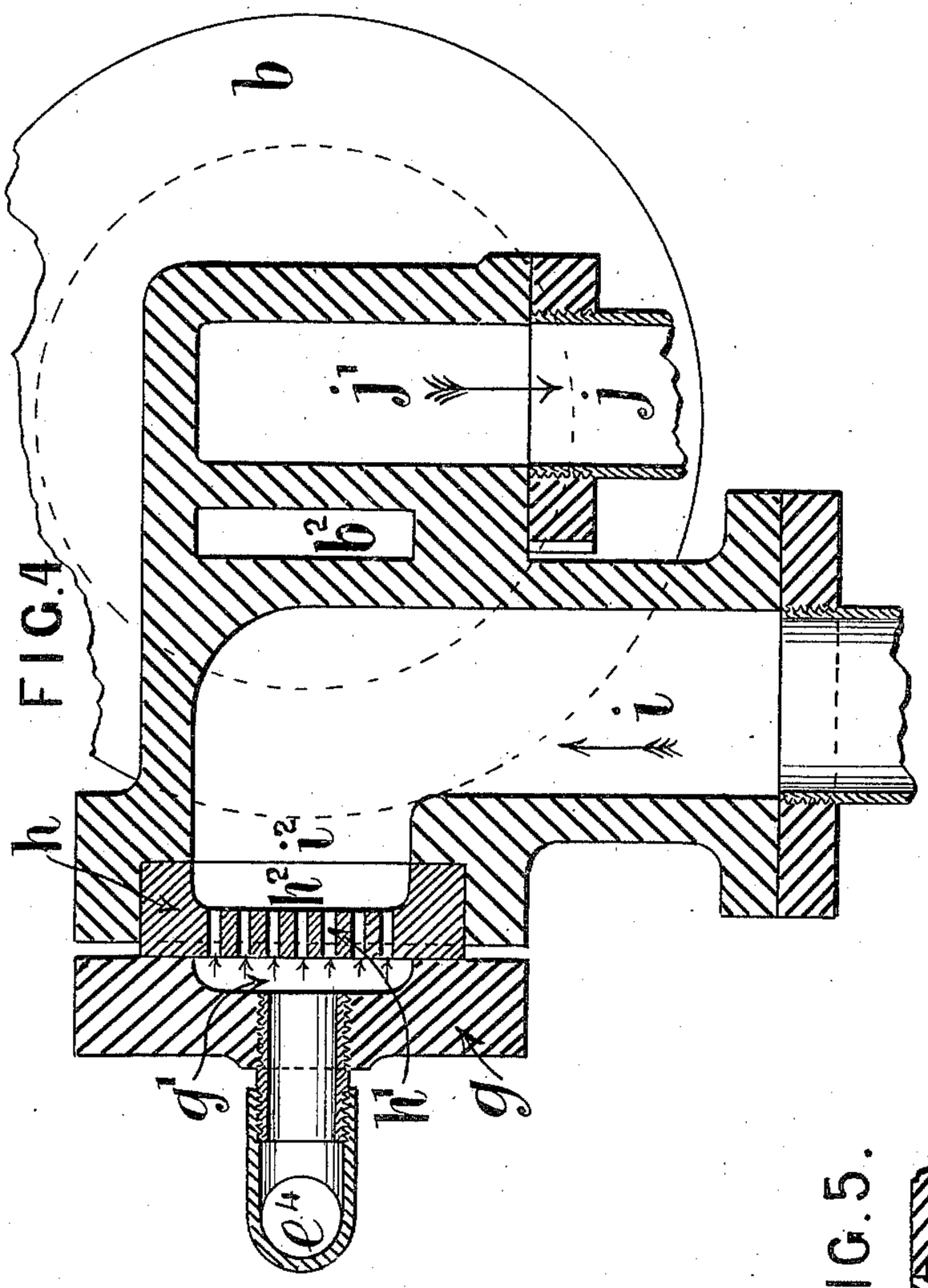


FIG. 6.

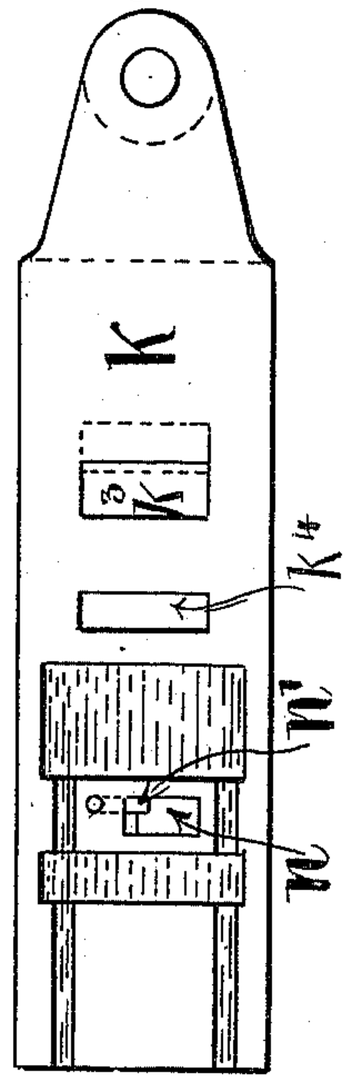


FIG. 3.

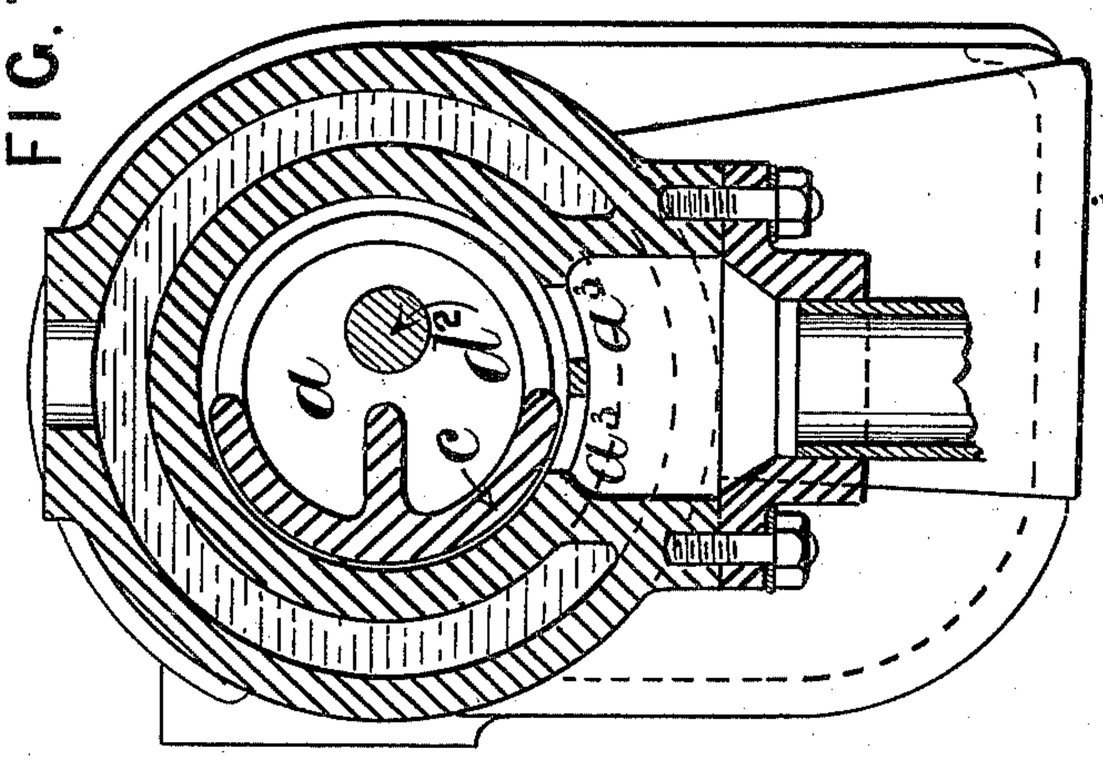
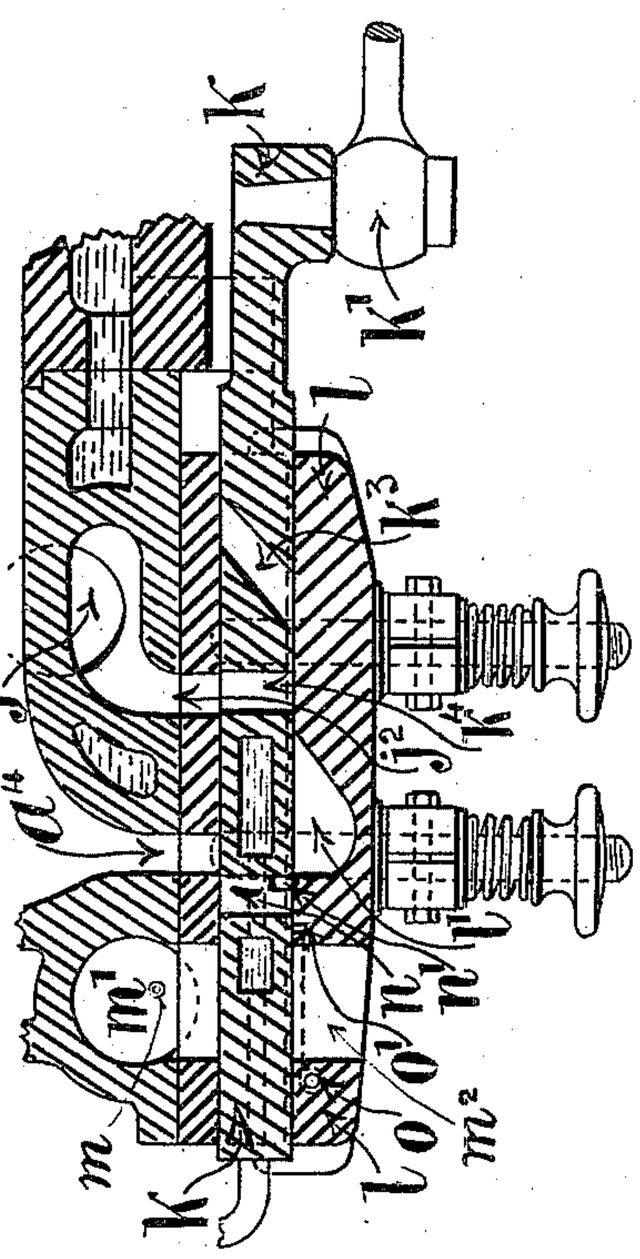


FIG. 5.



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4 Sheets—Sheet 4.

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GAS MOTOR ENGINE.

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FIG. 8.

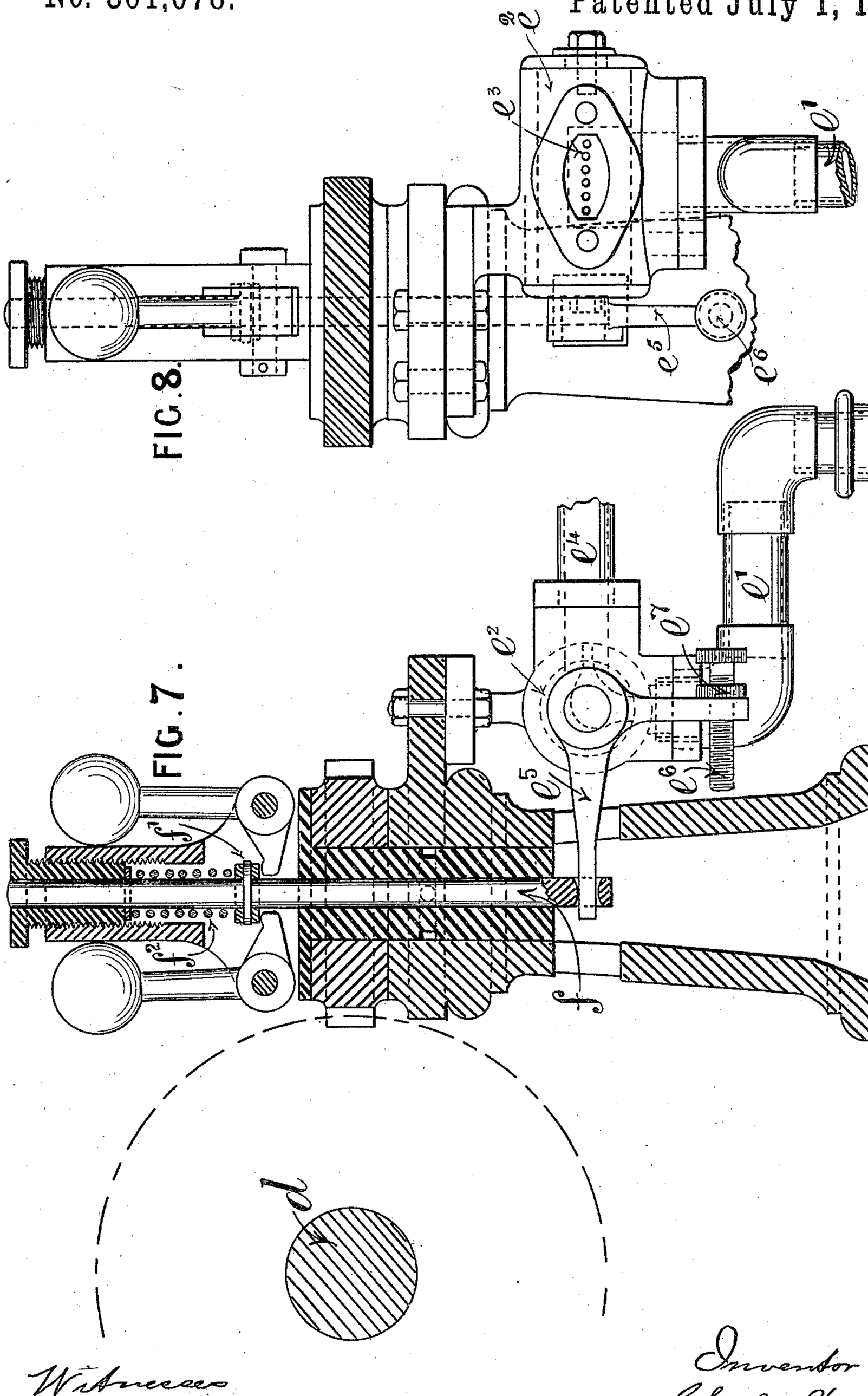

FIG. 7.

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UNITED STATES PATENT OFFICE.

CHARLES HENRY ANDREW, OF STOCKPORT, COUNTY OF CHESTER, ENGLAND.

GAS-MOTOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 301,078, dated July 1, 1884.

Application filed March 8, 1884. (No model.) Patented in England June 20, 1883, No. 3,066.

To all whom it may concern:

Be it known that I, CHARLES HENRY ANDREW, a subject of the Queen of Great Britain, residing at Stockport, in the county of Chester, England, have invented new and useful Improvements in Gas-Motor Engines, (for which I have obtained a patent in Great Britain, No. 3,066, bearing date June 20, 1883,) of which the following is a specification.

My invention relates to improvements in gas-motor engines; and the objects of my improvements are to produce an explosion, and so obtain one effective stroke of the piston at each revolution of the crank-shaft, and to expel the remaining products of a previous explosion from the power-cylinder by the inrush of the next charge of explosive mixture. I attain these objects by the mechanism illustrated in the accompanying five sheets of drawings, in which—

Figure 1 is a side elevation, and Fig. 2 a plan, both partly in section, of a gas-motor engine to which my improvements are applied. Fig. 3 is a vertical section on the line A B, Fig. 1. Fig. 4 is a vertical section, on an enlarged scale, on the line C D, Fig. 2. Fig. 5 is a detached view, on an enlarged scale, of the slide-valve which controls the admission of the explosive mixture to the power-cylinder. Fig. 6 is a plan view of the slide-valve shown in Fig. 5. Fig. 6^a is a plan view of the valve-cover, and Fig. 6^b is a plan view of the valve-cover and slide-valve. Figs. 7 and 8 are detached views, the former partly in section, of the governor and the valve which regulates the supply of gas to the engine.

Similar letters refer to similar parts throughout the several views.

The power or working cylinder *a* and the charging or compressing cylinder *b* are preferably arranged tandem, with their pistons *a'* and *b'* respectively cast in one piece with the web or frame *c*.

To the crank-shaft *d* is secured the crank *d'*, which is connected by the rod d^2 to the piston *a'* in the power-cylinder *a*. A combustion-chamber, a^2, is attached to and forms part of the power-cylinder *a*, and the admission of the charge of gas and air to this combustion-chamber is controlled by the slide-valve *k*. This valve *k* has a cover, *l*, and is reciprocated by a rod, *k'*, connected to an eccentric, k^2, on the crank-shaft *d*. The admission of gas to the engine is controlled by a valve regulated by and operated from the governor. (See Figs. 7 and 8.) Gas passes from the main supply through a gas-bag, *e*, and from thence through the pipe *e'*, to the valve. The pipe *e'* leads to the chamber of the plug-tap e^2. This chamber has a number of holes or perforations drilled in it, which correspond with holes e^3 in the barrel or body of the tap, and through which gas passes to the pipe e^4, and thence to the engine. An elbow-lever, e^5, is secured to the tap e^2, the axis of the plug of the tap forming the fulcrum of the elbow-lever, one arm of which is connected to the governor-spindle *f* in such manner that when the speed of the engine increases and the governor-balls raise the spindle *f* by means of a collar, *f'*, the elbow-lever e^5 turns the tap e^2 and partially or entirely closes the perforations e^3, and so partially or entirely shuts off the supply of gas from the engine. On the other hand, when the speed of the engine decreases, the spring f^2 or a weight overcomes the weight of the governor-balls and forces down the spindle *f* and turns the tap e^2 in the reverse direction, thus opening the perforations e^3 and again admitting gas to the pipe e^4. The movement of the elbow-lever e^5 may be limited and controlled by the set-screw e^6 and lock-nut e^7. The pipe e^4 is provided with a gas-bag, e^8, and is connected to an opening in the cover *g* of the slide-valve *h*, through which gas is admitted to the charging-cylinder *b*. The slide-valve *h* is provided with a vertical row of slots or perforations, *h'*, and the valve-cover *g* has a vertical passage, *g'*, corresponding with the perforations *h'* and communicating with the pipe e^4, so that when the perforations *h'* come opposite the vertical passage *g'* gas passes into the port h^2 in the slide-valve. The air-supply pipe *i* is connected to the slide-valve *h* by means of the passage i^2. During the outstroke of the piston *b'* in the charging-cylinder *b* the slide-valve *h* moves in the right-hand direction, and one end of the port h^2 comes opposite the passage b^2, leading to the charging-cylinder *b*, and the other end of the port h^2 comes opposite the

passage i^2, leading to the air-supply pipe i, while at the same time the perforations h' come opposite the passage g'; and as the piston b' continues its outstroke it draws gas from the pipe e^4 and air from the pipe i through the port h^2 and passage b^2, thereby thoroughly mixing them during their passage into the charging or compressing cylinder b; and when the mixed charge has been compressed during the instroke of the piston b' it is driven from the cylinder b through the passage b^2 and port h^3 in the slide-valve h, (which has been moved in the left-hand direction,) through the passage j' into the pipe or reservoir j, through which it is conducted to the combustion-chamber a^2. The slide-valve h controls the admission through the port h^2 and discharge through the port h^3 of the explosive mixture to and from the charging or compressing cylinder b. The slide-valve h is connected by a rod, h^4, and lever h^5 to a short shaft, h^6, connected to a slotted lever, h^7, actuated by a bowl on the strap of the eccentric k^2 on the crank-shaft d, and so operates the slide-valve h as the crank-shaft revolves.

The operation is as follows: To start the engine the fly-wheel d^3 is turned by hand or otherwise, and during the outstroke of the piston b' a charge of gas and air is drawn through the port h^2 and passage b^2 into the charging-cylinder b. On the return or in stroke of the piston b' the slide-valve h will have moved sufficiently in the left-hand direction to close the port h^2 and open the port h^3, and the explosive charge is driven or forced through the passage b^2, port h^3, and passage j' into the pipe or reservoir j. The explosive charge is conducted through the pipe j and admitted to the combustion-chamber a^2 of the power-cylinder a, through the slide-valve k, in the following manner: When the piston b' of the charging-cylinder b is about one inch from the end of its instroke, the piston a' in the power-cylinder a will be about one inch from the end of its outstroke—*i. e.*, near the exhaust-openings a^3. At this time the ports k^3 and k^4 in the slide-valve k will be opposite the small chamber l' in the valve-cover l, thus opening a communication between the passage j^2, leading from the reservoir j, and the passage a^4, leading to the combustion-chamber a^2. The mixed charge of gas and air under pressure rushes from the pipe or reservoir j through the passage j^2 and port k^3 into the small chamber l', and thence through the port k^4 and passage a^4 into the combustion-chamber a^2. The charge drives before it through the exhaust-openings a^3 any non-explosive vapor that may be contained both in the chamber a^2 and cylinder a. The piston a', on its return or in stroke, drives the charge before it from the cylinder a into the combustion-chamber a^2, and compresses it ready for explosion, while at the same time the piston b' is drawing a fresh charge of gas and air into the cylinder b.

During the instroke of the piston a' the ignition-pocket n in the slide-valve k comes over the passage o' in the valve-cover l, leading from the gas-supply pipe o, and receives a supply of gas through the slot n' previous to reaching the master light m, where the gas in the pocket n is ignited. The master light m is kept constantly burning in the chimney m' in a division of or near the combustion-chamber a^2. An opening, m^2, in the valve-cover l admits a current of air, which causes the gas in the pocket n to be ignited. When the piston a' has compressed the charge into the combustion-chamber a^2, and is on the point of beginning its reverse or out stroke in the position shown in Figs. 1 and 2, the slide-valve k will have been moved in the right-hand direction, and as the valve continues its traverse the flame in the pocket n ignites and explodes the mixture under pressure in the small chamber l' a moment in advance of uncovering the passage a^4, leading into the combustion-chamber a^2. This preliminary explosion in the chamber l' and pocket n instantly ignites and explodes the main charge in the combustion-chamber a^2. The result of the explosion of the main charge is to propel the working-piston a' outward until the edge of the exhaust-openings a^3 is uncovered, when the products of combustion, being in a state of considerable tension, will rapidly escape during the traverse of the piston over the said openings a^3 and be reduced to about atmospheric pressure, and before the openings a^3 are again covered by the piston a' on its inward stroke the remaining products of the previous explosion will have been expelled through the openings a^3 by the next charge of gas and air admitted to the combustion-chamber a^2 through the valve k, as already described. A small portion of the effective stroke of the piston a' is thus sacrificed for the purpose of expelling the remaining products of combustion by the inrush of a fresh charge of explosive mixture under pressure. When the slide-valve k is again moved in the left-hand direction, the waste gases in the ignition-pocket n escape through the opening m^2 in the valve-cover l previous to the pocket n receiving a fresh supply of gas, which is ignited at the master light m, as already described, and as the slide-valve k moves in the right-hand direction the flame in the pocket n again causes a preliminary explosion in the chamber l', and so in this manner explodes the main charge in the combustion-chamber a^2 at the commencement of each effective stroke of the engine.

My improvements are shown applied to a horizontal gas-engine only; but it is obvious that they are equally applicable to gas-engines of a vertical type.

Having stated the nature of my invention and described the manner of performing the same, I declare that what I claim, and desire to secure by Letters Patent of the United States, is—

1. The combination, in a gas-motor-engine, with the charging-cylinder b, provided with a

piston, b', and the passages b^2 and j', leading to the pipe j, of the slide-valve h, provided with ports h^2 h^3 and slots h', the port h^2 communicating by the passage i^2 with the air-pipe i, and the slots h' communicating by the passage g' with the gas-pipe e^4, substantially as and for the purposes herein set forth.

2. In a gas-motor engine, the combination, with the power-cylinder a, provided with a piston, a', combustion-chamber a^2, exhaust-openings a^3, and the passage a^4, of a slide-valve, k, having an ignition-pocket, n, a port, k^3, communicating with the preliminary explosion-chamber l' and with the pipe j by means of the passage j^2, and a port, k^4, communicating with the chamber l' and passage a^4, and the valve-cover l, provided with the aforesaid preliminary explosion-chamber l', passage o', and opening m^2, substantially as shown and described, for the purposes specified.

The foregoing specification of my improvements in gas-motor engines signed by me this 20th day of February, 1884.

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