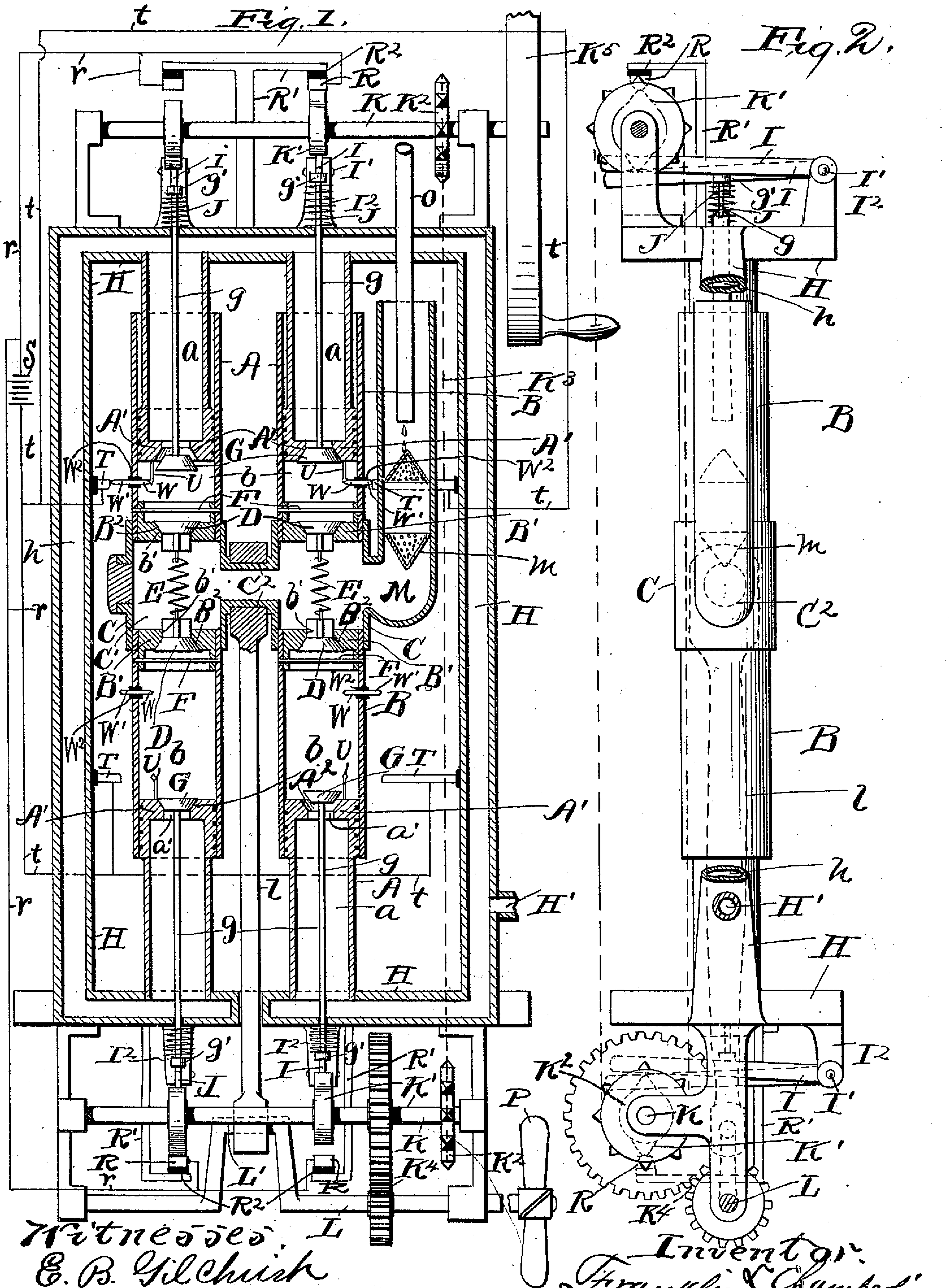
(No Model.) 2 Sheets—Sheet 1.

F. L. CHAMBERLIN.

INTERNAL COMBUSTION ENGINE.

No. 561,374. Patented June 2, 1896.



Witnesses:
E. B. Gilchrist

Inventor:
Franklin L. Chamberlin
By M. D. Leggett & Co
his attorneys.

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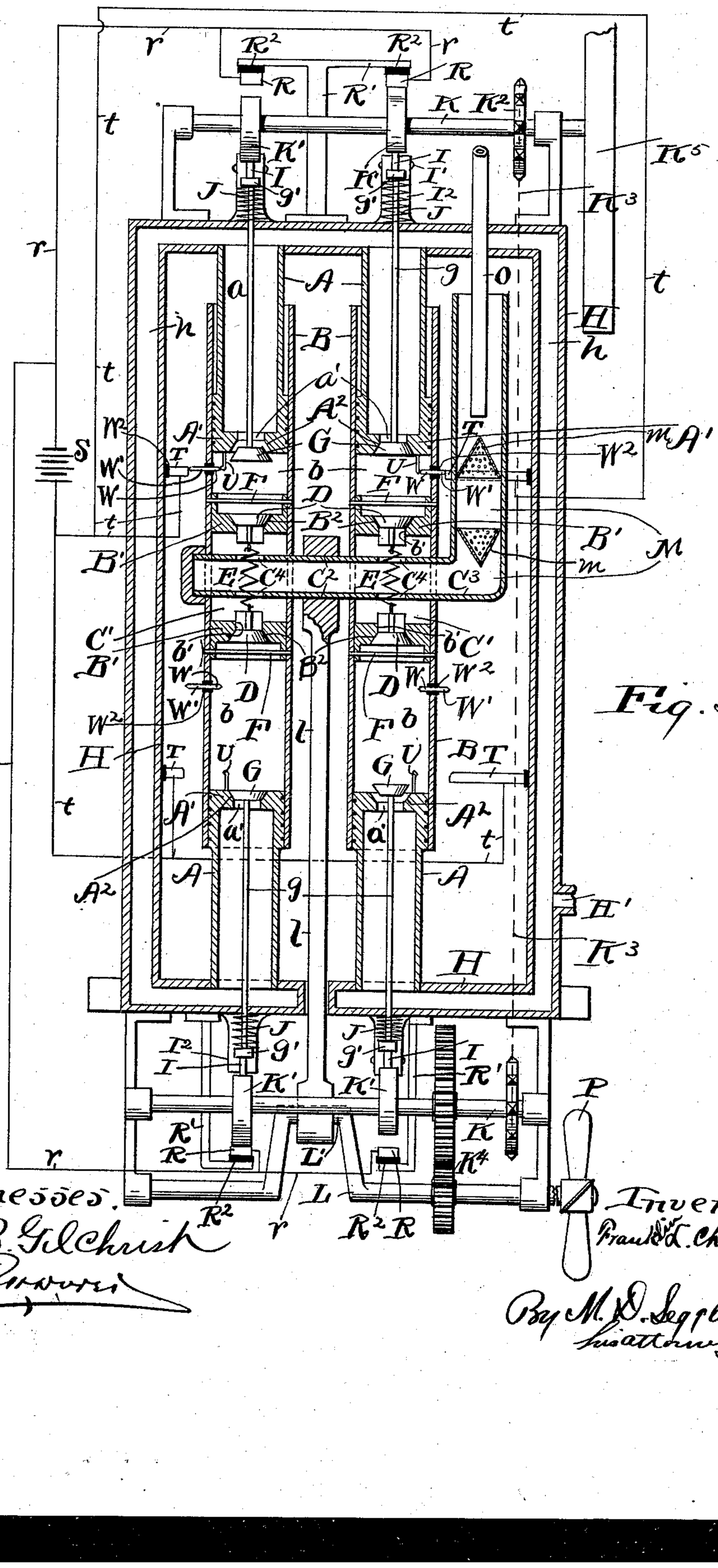

Fig. 3.

Witnesses.
E. B. Gilchrist
Crowell

Inventor
Frank L. Chamberlin
By M. D. Leggett & Co.
his attorneys.

UNITED STATES PATENT OFFICE.

FRANKLIN L. CHAMBERLIN, OF CLEVELAND, OHIO.

INTERNAL-COMBUSTION ENGINE.

SPECIFICATION forming part of Letters Patent No. 561,374, dated June 2, 1896.

Application filed June 22, 1895. Serial No. 553,665. (No model.)

To all whom it may concern:

Be it known that I, FRANKLIN L. CHAMBERLIN, of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Internal-Combustion Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

My invention relates to improvements in internal-combustion engines that are especially well adapted for use in the propulsion of small water-crafts and vehicles; and my invention consists in certain features of construction and combinations of parts hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation, mostly in central vertical section, of an engine embodying my invention. Fig. 2 is an elevation in vertical section, on line 2 2, Fig. 1, showing portions broken away. Fig. 3 is a side elevation, partly in central vertical section.

My improved engine comprises any desired number of stationary exhaust-cylinders A and an endwise-reciprocating cylinder B for each cylinder A, said cylinder B nicely embracing and being adapted to move endwise of the respective cylinder A. In the case illustrated two stationary cylinders A and embracing and movable cylinders B are provided in the upper portion of the engine, and two stationary cylinders A and movable cylinders B are provided below said upper cylinders. Each of the lower stationary cylinders is arranged in line with one of the upper stationary cylinders, and said two cylinders are located a suitable distance apart, and the embracing movable cylinders upon said two stationary cylinders in Fig. 1 are shown connected with each other at adjacent ends by a coupling C. The cylindrical shells of the movable cylinders that are arranged in line may, however, be composed of a single tube or piece, as shown in Fig. 3.

The explosive mixture employed in the operation of the engine is introduced, preferably as hereinafter described, into chambers C′, formed between the cylinders B, that are arranged in line, and each cylinder B, at the end contiguous to the adjacent chamber C′, is provided with a head B′, that has a port b' therethrough adapted to establish communication between said chamber C′ and chamber b of the respective cylinder, and constituting the induction-port of said cylinder. Head B′ of each cylinder B, at the inner end of its port b', is provided with a seat B^2 for a valve D, adapted to control the passage-way afforded by the induction-port and adapted to move into the cylinder in opening, and actuated from its seat by a partial vacuum or suction created within the chamber of said cylinder. A spring E acts to retain said valve D in its closed position, and a stop F limits the movement of the valve in opening. Stop F consists, preferably, of a pin extending through the chamber of the cylinder a suitable distance from the inner end of the port controlled by the valve. A single spring E is preferably employed for the induction-valves of each pair of connected cylinders that are arranged in line, said spring being located within the chamber C′, formed between said cylinders and having its opposite ends attached to the two different valves, respectively, and arranged so as to normally retain both valves in their closed position. When, therefore, a partial vacuum or suction is created in either one of said cylinders, the induction-valve of said cylinder is actuated or drawn from its seat, thereby permitting the passage of the explosive mixture from the contiguous chamber C′ to the cylinder-chamber in which the explosive mixture is subsequently compressed and thereupon ignited.

Chamber a of each exhaust-cylinder A, at the end of said cylinder that is embraced by the engaging cylinder B, is provided with a head A′ that has a port a' therethrough, which port is adapted to establish communication between the chambers of said cylinders, and constitutes the exhaust or eduction port for said cylinder B. Head A′ at the receiving end of the port therethrough is provided with a seat A^2 for a valve G, adapted to move into the contiguous cylinder-chamber b in opening and provided with a stem g, that extends upwardly through the chamber of the respective exhaust-cylinder and through the chamber of a suitably-supported case H, connected with the discharging end of said cyl-

inder, and the chamber *h* of which case is in open relation with the chamber of said exhaust-cylinder. Each valve-stem *g* extends outside of case H, and at its outer end is provided with a head *g'*, adapted to be engaged by a lever I, that is fulcrumed at I' to any stationary object—such, for instance, as a standard I^2, rigid with case H—and a spring J, confined upon said valve-stem between the head of the stem and case H, acts in the direction to retain the valve in its closed position. A lever I is shown provided for each valve-stem *g*, and said lever is adapted to be actuated by a cam K', operatively mounted or formed upon a shaft K, supported in any approved manner. Two cam-shafts K are therefore in the case illustrated provided at the upper end and lower end, respectively, of the engine, and the two cam-shafts are operatively connected with each other by means of sprocket wheels and chain K^2 K^3, respectively.

Case H extends from over the upper stationary cylinders downwardly at opposite sides of the engine to and in under the lower stationary cylinders, and its chamber *h* at any convenient point communicates with the exhaust-pipe H'.

One of cam-shafts K is shown intergeared, as at K^4, with the engine-shaft L, and the other cam-shaft is shown provided with a hand-wheel K^5 instrumental in starting the engine.

Engine-shaft L is arranged horizontally and suitably supported at one end of the engine, and at the lower end of the engine illustrated and at its central portion is provided with a crank L', operatively connected by means of a rod or pitman *l* with the reciprocating cylinders of the engine, said pitman or connecting rod at its upper end embracing a wrist connected with said cylinders. Wrist C^2 in Fig. 1 is shown formed upon couplings C, whereas in Fig. 3 said wrist is formed by a pipe C^3, that extends through both chambers C'. Wrist C^2 is tubular and connects and establishes communication between chambers C', that are in open relation with the air and oil mixing chamber M, open at its outer end for the admission of air and in open relation at any suitable point with the oil-supply pipe O, that is shown extending into the mixing and vaporizing chamber, and chamber M is shown provided with any suitable number of suitably-shaped perforated diaphragms *m* between the discharging end of pipe O and the eduction end of said chamber. In Fig. 3 pipe C^3 is perforated as required, as at C^4, to accommodate the location and operation of springs E and the passage of the explosive compound from said pipe into chamber C' and consequently to the induction-ports.

If the engine is used in the propulsion of a water-craft, for which it is especially well adapted, the propeller-wheel P of the water-craft may be operatively mounted upon the engine-shaft, which in said case would constitute the propeller-shaft.

I would here remark that springs J, that act to retain the exhaust-valves seated, have a tension sufficiently greater than the tension of springs E, that act to retain the induction-valves in their closed position, that the exhaust or induction port of any one of cylinders B shall not open when the induction-valve of the cylinder is drawn from its seat by a partial vacuum or suction created in the cylinder.

The arrangement of cams K' and four reciprocating cylinders shown is preferably such that when any one of said cylinders is making the stroke immediately following the explosion of the explosive compound compressed therein the remaining three cylinders shall be making the drawing-stroke, compressing-stroke, and exhaust-stroke, respectively, or, in other words, the arrangement of parts is preferably such that the explosion or dilatation of the explosive compound occurs successively in the different cylinders, and an impulse is given to the connecting-rod during every reciprocation or movement of said rod, by which arrangement greater power is obtained, and no heavy fly-wheels, or no fly-wheels at all, are required. In Fig. 1 of the drawings the upper movable cylinder at the left hand is shown in position, having completed its exhaust-stroke with the exhaust or eduction valve still open. The lower movable cylinder at the left hand is shown in position at the completion of its drawing-stroke. The upper movable cylinder at the right hand is shown in position at the terminus of its compressing-stroke, and the lower movable cylinder at the right hand is shown in position at the completion of the stroke immediately following the dilatation of the ignited compound in said cylinder with the exhaust-valve already open, as required, for the next succeeding exhaust-stroke of the cylinder.

The ignition of the compressed explosive compound within any cylinder B upon the compressing-stroke of said cylinder is preferably effected by an electric spark produced in the chamber of said cylinder upon the completion of said stroke. Any well-known means for the production of an electric spark for the purpose indicated may be employed. For the production of said electric spark I construct the cylinders, case H, cam-shafts, and supporting brackets or standards of a material capable of conducting an electric current and provide a contact R adjacent to each cam K' and in position to be engaged by the cam when the reciprocating cylinder whose exhaust-valve's stem is adapted to be engaged by said cam is at or approximately at the completion of its compressing-stroke. Contacts R are supported in any approved manner—for instance, by brackets R', rigid with case H—but are electrically insulated from their supports, as at R^2. Each contact

R is electrically connected by means of wire *r* with one of the terminals of an electric source S.

Each exhaust-cylinder is provided with a contact U, projecting into the chamber of the engaging movable cylinder B and adapted to be electrically engaged by a contact W on said movable cylinder upon the completion of the compressing-stroke of said movable cylinder. Another contact, W′, electrically connected with the aforesaid contact W, is upon or somewhat before the completion of said stroke of the movable cylinder adapted to electrically engage a contact T, supported but electrically insulated from case H and electrically connected by means of wire *t* with the other terminal of the electric source. Contacts W and W′ are electrically insulated from their supporting-cylinder, as at W^2, and contacts U are of course, through the medium of the exhaust-cylinders, case H, and cam-shafts, electrically connected with the cams upon said shafts. The arrangement of parts is such that the cam for opening the exhaust-valve of a reciprocating cylinder shall electrically engage the adjacent contact R once in every rotation of the engine-shaft; that contact W′ on said cylinder, although the same comes into engagement with its coöperating contact T twice during every rotation of the engine-shaft, shall have come into electrical engagement with said contact T when electrical contact takes place between the aforesaid cam and contact R, and that contact W on said cylinder shall make and break contact with its coöperating stationary contact U before electrical engagement ceases between the aforesaid contacts W′ and T and between the aforesaid cam and contact R, so that an electric spark shall be produced by said establishment and interruption of electrical engagement between contacts W and U.

The operation of the illustrated engine will be readily understood and is as follows: The explosive compound is in readiness within the chambers C′. The opening of the induction-valve of any one of said cylinders will, after the engine has been started and against the action of the spring acting to retain the valve closed, accompany the drawing-stroke of said cylinder and admit the explosive compound to the cylinder-chamber. The next succeeding stroke of the cylinder will close said valve and compress the compound admitted to the cylinder-chamber during the preceding stroke. The ignition of the compressed compound will take place at the completion of the compressing-stroke. The resultant dilatation of the gases will give an impulse to the cylinder in the opposite direction, whereupon follows the exhaust-stroke of the cylinder whose exhaust or eduction valve is mechanically opened at or immediately before the commencement of the exhaust-stroke.

What I claim is—

1. In an internal-combustion engine, the combination of a stationary head having a port therethrough, a movable cylinder embracing and adapted to reciprocate endwise of the said head, the movable cylinder having an induction-port, a passage-way for conducting the explosive compound to said induction-port, suitably-actuated valves for controlling said ports, means for igniting the compressed explosive compound within the movable cylinder, engine-shaft, and pitman or connecting rod operatively connected at opposite ends with the movable cylinder and crank of the shaft, respectively, all arranged and operating substantially as set forth.

2. In an internal-combustion engine, the combination of a stationary head, a reciprocating cylinder embracing and movable endwise of said head, induction-port leading to the chamber of said cylinder, a valve for controlling said port and adapted to move toward or into cylinder-chamber in opening, a spring acting to retain said valve closed, an eduction or exhaust port leading from said chamber, a valve for controlling the exhaust-port and adapted to move toward or into the cylinder-chamber in opening, a spring acting to retain said exhaust-valve closed, means for opening said valve, a passage-way for conducting the explosive compound to the induction-port, means for igniting the explosive compound within the aforesaid chamber, engine-shaft, pitman or connecting rod operatively connected at opposite ends with the cylinder and crank of the shaft, respectively, all operating substantially as indicated, and the spring acting upon the exhaust-valve having a tension sufficiently greater than the spring acting upon the induction-valve that the latter only shall open during the drawing stroke of the cylinder.

3. In an internal-combustion engine, the combination of a stationary head, a movable cylinder embracing and adapted to reciprocate endwise of said head, induction-port leading to the chamber of said cylinder, a valve for controlling said port, a spring acting to retain the valve closed, said valve being arranged to be opened by suction created within the cylinder, an eduction or exhaust port for the cylinder, a valve for controlling the exhaust-port, said valve having a stem, a spring acting to retain said exhaust-valve closed during the drawing-stroke of the cylinder, a passage-way for conducting the explosive compound to the induction-port, means for igniting said compound within the cylinder-chamber, engine-shaft, pitman or connecting rod operatively connected at opposite ends with the cylinder and crank of the shaft, respectively, a cam-shaft operatively connected with the engine-shaft and having a cam arranged to engage and actuate the stem of the exhaust-valve in the direction required to open said valve, all arranged and timed to operate, substantially as set forth.

4. In an internal-combustion engine, the combination of stationary heads arranged a

suitable distance apart, a movable cylinder for each of said heads, said cylinder embracing and being adapted to reciprocate endwise of the respective head, induction-ports leading to the chambers of the cylinders, eduction or exhaust ports leading from said chambers, suitably-actuated valves for controlling said ports, means for igniting the explosive compound within said chambers, engine-shaft, and pitman or connecting rod operatively connected at one end with the aforesaid cylinders and operatively connected at its opposite end with the crank of the shaft, all operating substantially as set forth.

5. In an internal-combustion engine, the combination of the engine-shaft, four reciprocating cylinders arranged substantially as indicated, a stationary head for each cylinder, said head fitting the cylinder internally, a pitman or connecting rod operatively connected at one end with all of said cylinders and operatively connected at its opposite end with the crank of the shaft, induction-ports leading to the chambers of the cylinders, eduction or exhaust ports leading from said chambers, suitably-actuated valves for controlling said ports, and means for igniting the explosive compound within the cylinder-chambers, all timed to operate substantially as set forth.

6. In an internal-combustion engine, the combination of two stationary heads arranged *vis-à-vis* and a suitable distance apart, two connected cylinders embracing and movable endwise of the different heads, respectively, an induction-port leading to each cylinder-chamber, a valve for controlling said port and adapted to be opened by suction created within said cylinder-chamber, a spring acting to retain both induction-valves closed, eduction or exhaust ports leading from the aforesaid chambers, suitably-actuated valves for controlling the exhaust-ports, means for igniting the explosive compound within the cylinder-chambers, engine-shaft, and pitman or connecting rod operatively connected at one end with both of the cylinders, and operatively connected at the opposite end with the crank of the shaft, all operating substantially as set forth.

7. In an internal-combustion engine, the combination of the engine-shaft, reciprocating cylinders arranged in pairs, with the cylinders of each pair of cylinders arranged end to end and a suitable distance apart, and operatively connected with the engine-shaft, a chamber suitably formed between adjacent ends of the cylinders of each pair of cylinders, induction-ports leading from said chamber to the adjacent cylinder-chambers, a stationary head for each cylinder, said head fitting the cylinder internally, eduction or exhaust ports leading from the cylinder-chambers, suitably-actuated valves for controlling the induction-ports and exhaust-ports, a chamber wherein the explosive compound is formed, a pipe establishing communication between said last-mentioned chamber and the chambers formed between the cylinders of the aforesaid pairs of cylinders, and suitable means for igniting the explosive compound within the cylinder-chambers, substantially as set forth.

8. In an internal-combustion engine, the combination of the engine-shaft, reciprocating cylinders arranged in pairs with the cylinders of each pair arranged end to end and a suitable distance apart, a chamber suitably formed between adjacent ends of the cylinders of each pair of cylinders, induction-ports leading from said chamber to the adjacent cylinder-chambers, a stationary head for each cylinder, said head fitting the cylinder internally, eduction or exhaust ports leading from the cylinder-chambers, suitably-actuated valves for controlling the induction-ports and exhaust-ports, a chamber wherein the explosive compound is formed, a tubular wrist suitably secured to and having the passage-way therethrough communicating with the chambers formed between the cylinders of the aforesaid pairs of cylinders, and a passage-way establishing open relation between one of said last-mentioned chambers and the chamber wherein the explosive compound is formed, pitman or connecting rod operatively connected at one end with said wrist and operatively connected at its opposite end with the crank of the shaft, and suitable means for igniting the explosive compound within the cylinder-chambers, substantially as set forth.

9. In an internal-combustion engine, the combination of a stationary head, a movable cylinder embracing and adapted to reciprocate endwise of said head, induction-port leading to the chamber of said cylinder, a valve for controlling said port, a spring acting to retain the valve closed, said valve being arranged to be opened by suction created within the cylinder, an eduction or exhaust port for the cylinder, a valve for controlling the exhaust-port, said valve having a stem, a spring acting to retain said exhaust-valve closed during the drawing stroke of the cylinder, a passage-way for conducting the explosive compound to the induction-port, engine-shaft, pitman or connecting rod operatively connected at opposite ends with the cylinder and crank of the shaft, respectively, a cam-shaft operatively connected with said shaft and having a cam arranged to engage and actuate the stem of the exhaust-valve in the direction required to open said valve, an electric source, a stationary contact supported from the aforesaid head and electrically connected with the cam, said contact projecting into the cylinder-chamber, another stationary contact electrically connected with one of the terminals of the electric source and adapted to be electrically engaged by the cam, another stationary contact electrically connected with the other terminal of the electric source, and two contacts on and movable with the cylinder and electrically connected

with each other but electrically insulated from the cylinder, one of said movable contacts being adapted to electrically engage the aforesaid last-mentioned stationary contact and the other movable contact being adapted to electrically engage the contact on the aforesaid head, all arranged and timed to operate substantially as and for the purpose set forth.

In testimony whereof I sign this specification, in the presence of two witnesses, this 18th day of April, 1895.

FRANKLIN L. CHAMBERLIN.

Witnesses:
C. H. DORER,
L. WARD HOOVER.