No. 680,907. Patented Aug. 20, 1901.

A. F. BARDWELL.

MULTIPLE CYLINDER EXPLOSIVE ENGINE.

(Application filed Nov. 3, 1900.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

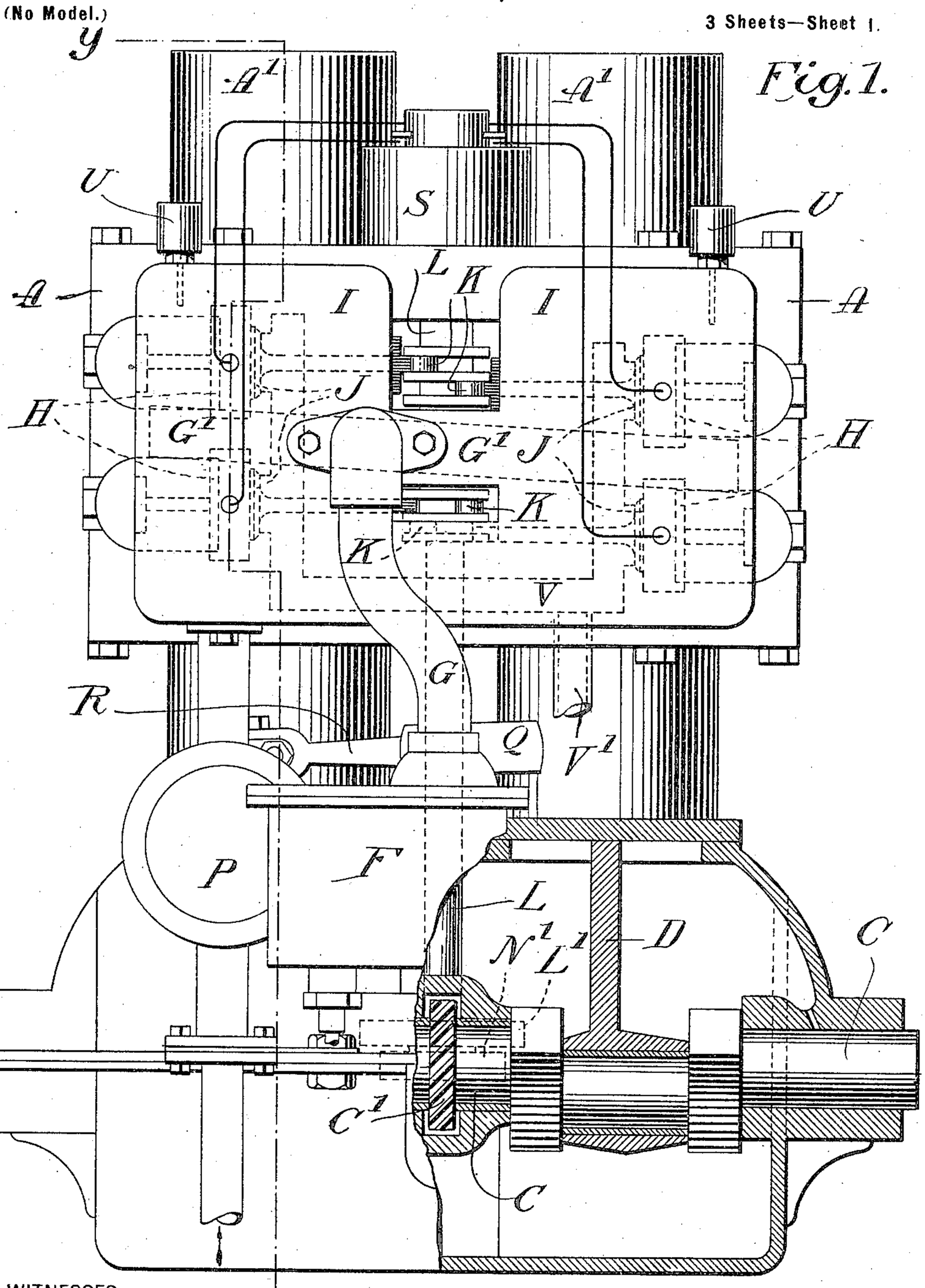

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Fig. 2.

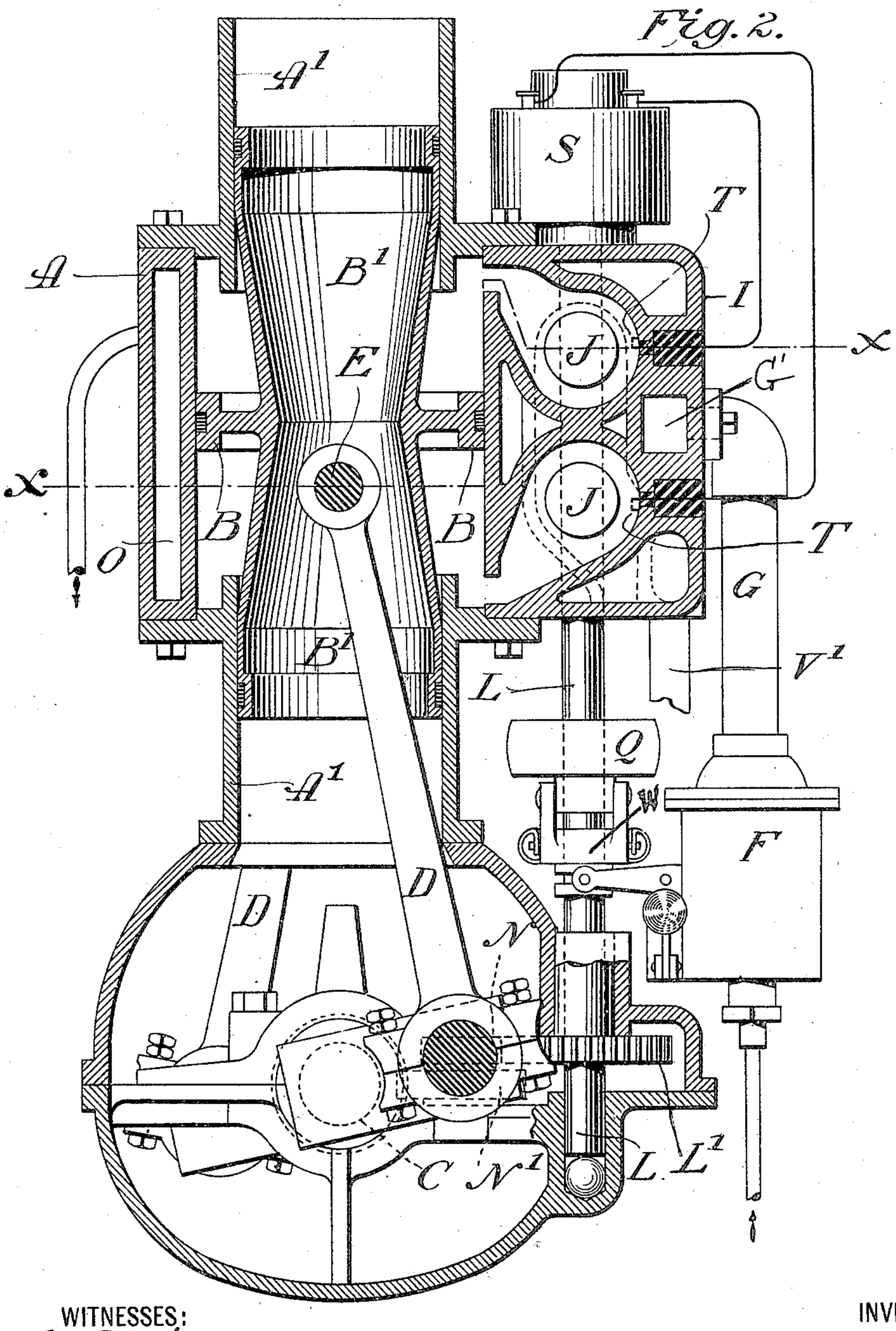

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Fig. 3.

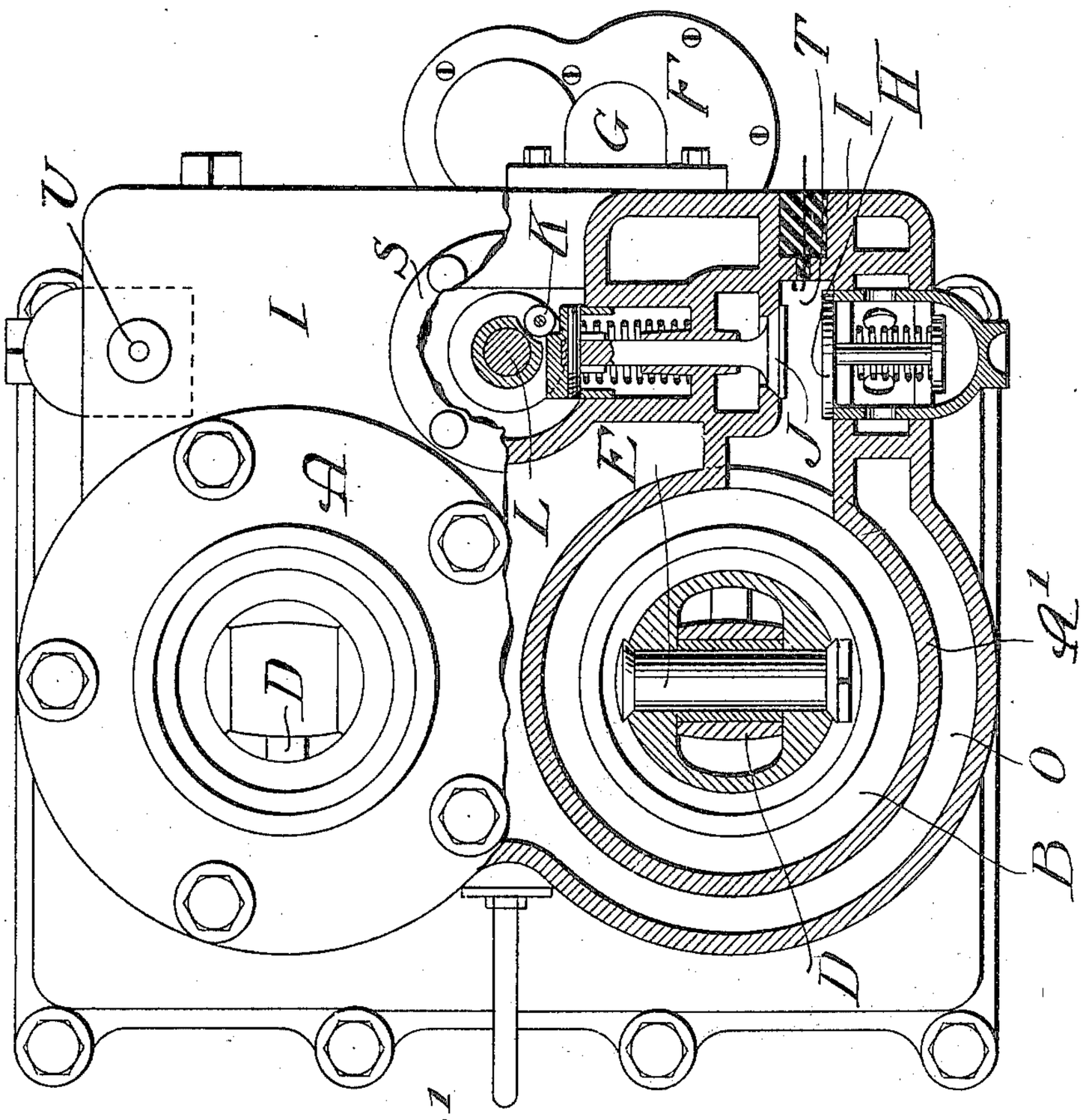
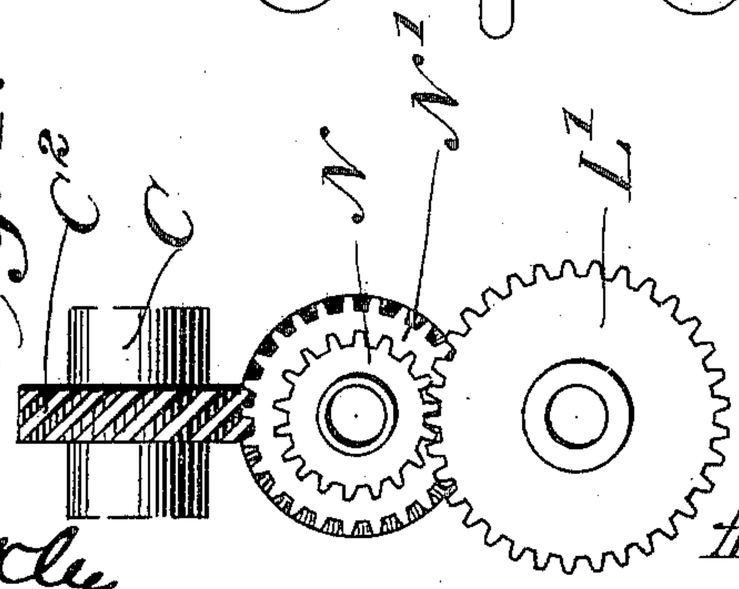


Fig. 4.



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MULTIPLE-CYLINDER EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 680,907, dated August 20, 1901.

Application filed November 3, 1900. Serial No. 35,339. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR F. BARDWELL, a citizen of the United States, residing at Mount Vernon, Westchester county, New York, have invented certain new and useful Improvements in Gas-Engines, of which the following is a full, clear, and exact description.

My invention relates to motors, particularly of the type termed "gas-engines."

The main objects of my invention are simplicity, effectiveness, durability, safety, and economy. The engine shown in the drawings is of the four-cycle twin-cylinder type, and the construction is such that each piston receives an impulse at each end in a single stroke thereof. Consequently by arranging the cylinders in pairs I am enabled to secure two impulses—that is, a push and a pull—for each revolution of the crank-shaft.

In the drawings, Figure 1 is a side elevation of an engine of my improved construction, said view being partly in section. Fig. 2 is a cross-section on the line Y Y, Fig. 1, some of the parts being shown in elevation. Fig. 3 is a plan view of the engine, the same being shown partly in section on the line X X, Fig. 2. Fig. 4 is a view of details of construction.

Although the drawings show two cylinders A A, it will be necessary to describe the construction and mode of operation of only one of them, since they are alike, and each constitutes practically a complete motor. It has been found, however, that the most successful results can be obtained by the employment of two or more cylinders.

B is a piston movable within the cylinder A.

B′ B′ are extensions at each end of the piston, preferably hollow and of slightly-tapered form, as shown in Fig. 2. These extensions B′ B′ perform practically the function of a piston-rod, the same receiving bearing support in the cylindrical extensions A′ A′ of the cylinder A.

C is a crank-shaft, the cranks of which are connected to the pistons B B by rods D D. Each of the connecting-rods D is attached to its respective piston by a pin E, and for the purposes of compactness and strength this connection of the rod to the piston is made within one of the extensions B′ and close to the piston proper.

F is a carbureter.

G is a pipe leading from the carbureter F to the base of the admission-valves H H, located within the valve-casing I. J is an exhaust-valve located in said casing.

K K are eccentrics on the shaft L, which is rotated at a definite speed with respect to the engine, so as to open the exhaust-valves J J at the proper moment. Each cylinder has an admission-valve and an exhaust-valve for each end. Each exhaust-valve has its own eccentric K. The admission-valve may be of a suitable puppet type. The shaft L carries a gear L′, meshing with a reducing-gear N, which gear N is fixed to and rotates with a gear N′, which latter is in mesh with and rotated by a gear C^2, carried by the crank-shaft C. The gears C^2 N′ may be spiral gears, adapted to transmit motion to the direct gear N, which is placed at right angles to C^2.

O is a water-jacket through which a circulation of water may be maintained by a suitable pump P, which may be operated by an eccentric Q, mounted upon the shaft L, the eccentric Q being connected with said pump by a rod R or by any other desired means.

S is a controller of suitable form, by which electric sparks may be formed within the explosion-chambers at the proper time.

T T are suitable sparking devices located within the explosion-chambers. Obviously the method of igniting the charge is immaterial, since any suitable igniting device might be substituted for that shown.

U U are oil receptacles or cups adapted to carry cylinder-lubricating oil, which may be fed drop by drop to a point closely adjacent to each of the admission-valves H and in the path of each swiftly-inrushing charge of the explosive mixture as it is drawn into the cylinder. This cylinder-oil drops into the path of said inrushing charge and is atomized thereby and mingles therewith within the cylinder and lubricates its walls. When a plurality of cylinders is used, as is preferable and as shown in Fig. 1, the fuel-supply pipe G may communicate with a gas-passage G′, (indicated by dotted lines, Fig. 1,) which branches off from the pipe G and leads to each of the admission-ports. Thus all the charges may be derived from a single source of supply, such as the carbureter F. The exhaust-

valves may also be connected by a passage V, (shown in dotted outline, Fig. 1,) from whence communication with the outside air may be effected through a suitable passage or discharge-tube V′.

In the operation of the engine shown in the drawings two impulses are given at each revolution of the crank-shaft. Looking at Fig. 1, assume that the piston is in the upper portion of the left-hand cylinder and has a charge of gas under compression. Assume also that a charge of gas has just been drawn into the same cylinder underneath the piston. In the right-hand cylinder the piston will be at the lower end of the cylinder, and it may be assumed it has just scavenged the lower end thereof. The space above the right-hand piston is filled with an inert gas. When the engine is started under these conditions, the first impulse is given to the piston in the left-hand cylinder and the piston is forced downward by the explosion of gas above it, and this downward movement compresses the gas underneath it. In the right-hand cylinder the piston has moved upwardly and has forced out the inert gas and drawn in from below a fresh supply of gas. The second impulse is given to the under side of the piston in the left-hand cylinder by the explosion of the gas driving said piston up and scavenging the upper portion of the said cylinder. While this piston is going up the piston in the right-hand cylinder is moving down, compressing the gas underneath the same ready to be ignited. This downward movement of the right-hand piston draws in a charge of gas from above. When the gas below the piston in the right-hand cylinder is ignited, it expands, and the third impulse is given, forcing the said piston up, compressing the gas above it. This upward movement of the piston in the right-hand cylinder causes the downward movement of the piston in the left-hand cylinder, which movement ejects the dead gas therein. The fourth impulse is given to the upper end of the piston in the right-hand cylinder. In this way each motor (meaning one cylinder and its associated parts) works for a time and rests for a time, and consequently will not become overheated. Because each motor is double-acting each of them is capable of developing the maximum power with the minimum weight. It possesses a great advantage in that it may be very compactly built, and consequently may be employed where space is an important element to consider, as it is, for example, in automobiles and the like. By having two impulses for each revolution of the main shaft the vibration usually attendant in explosive-engines is reduced to a minimum. Because of the frequency of the impulses a smaller fly-wheel is required than would be the case were the impulses less frequent. The working parts of this engine are not liable to become overheated, because they are thoroughly water-jacketed and because there is a large surface exposed to air circulation. By making the piston B of annular form or with an opening through the same and its extensions B′ of tubular form air is free to pass through the same, making a large radiating surface directly through the center of each motor. This construction permits the easy oiling of the cross-head pin E and the bearings for the crank-shaft C′, which latter may either run in oil or may be supplied with oil by dropping it in from above.

The fact that the impulses are given with such frequency relatively to the speed of the engine makes it very sensitive to a governing device, and consequently its speed may be automatically controlled to a nicety.

A governing device of suitable form, as indicated at W, may be provided; but as the particular form of the same is not essential to this invention it need not be described in detail herein; but the form shown will be made the subject-matter of another application.

The engine described is of the four-cycle type; but it is clear that many of the advantages of operation secured by the construction shown may well be obtained in other types of engines by an equivalent construction.

What I claim is—

1. In a gas-engine in combination, a cylinder, a piston movable therein, tapered tubular extensions at each end of said piston forming a contracted but open air-passage, bearings in said cylinder for said tubular extensions, and suitable admission and exhaust valves for each end of the cylinder.

2. In a gas-engine, in combination, a cylinder, an annular piston therein, tubular extensions of cylindrical form projecting from said cylinder, and tubular extensions of tapered form projecting from said piston and a contracted but open air-passage through said piston and its extensions.

3. In a gas-engine in combination, a cylinder, an annular piston movable therein, tubular extensions at each end of said piston in communication with each other through said piston and open to the air at all times, bearings in said cylinder for said tubular extensions, and admission and exhaust valves for each end of said cylinder.

4. In a gas-engine in combination, a piston, a tubular extension at each end thereof, and an air-passage through said piston and said extensions, said passage being open to the air at all times.

5. In a gas-engine, in combination, a cylinder, an annular piston movable therein, tubular extensions of cylindrical form projecting from said cylinder and tubular extensions of tapered form projecting from said cylinder, and a contracted but open air-passage through said piston and its extensions, and a connecting-rod one end of which projects in and is secured within said passage.

6. In a double-acting four-cycle gas-engine,

an annular piston having a tapered annular piston extension of tubular form, and means within said piston extension comprising a connecting-rod connection.

7. In a double-acting four-cycle gas-engine, an annular cylinder, a piston, a tubular extension on each end of said piston, a uniformly-open air-passage through said piston and tubular extension, a bearing for said tubular extension, admission and exhaust valves and means for actuating the same.

8. In a gas-engine in combination, a plurality of cylinders, an annular piston in each of said cylinders, tubular extensions at each end of each of said pistons, and an air-passage through each of said tubular extensions, said air-passages being in communication with each other.

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