(No Model.) 2 Sheets—Sheet 1.

E. D. STRONG.

EXPLOSIVE ENGINE.

No. 597,921. Patented Jan. 25, 1898.

Fig. 1.

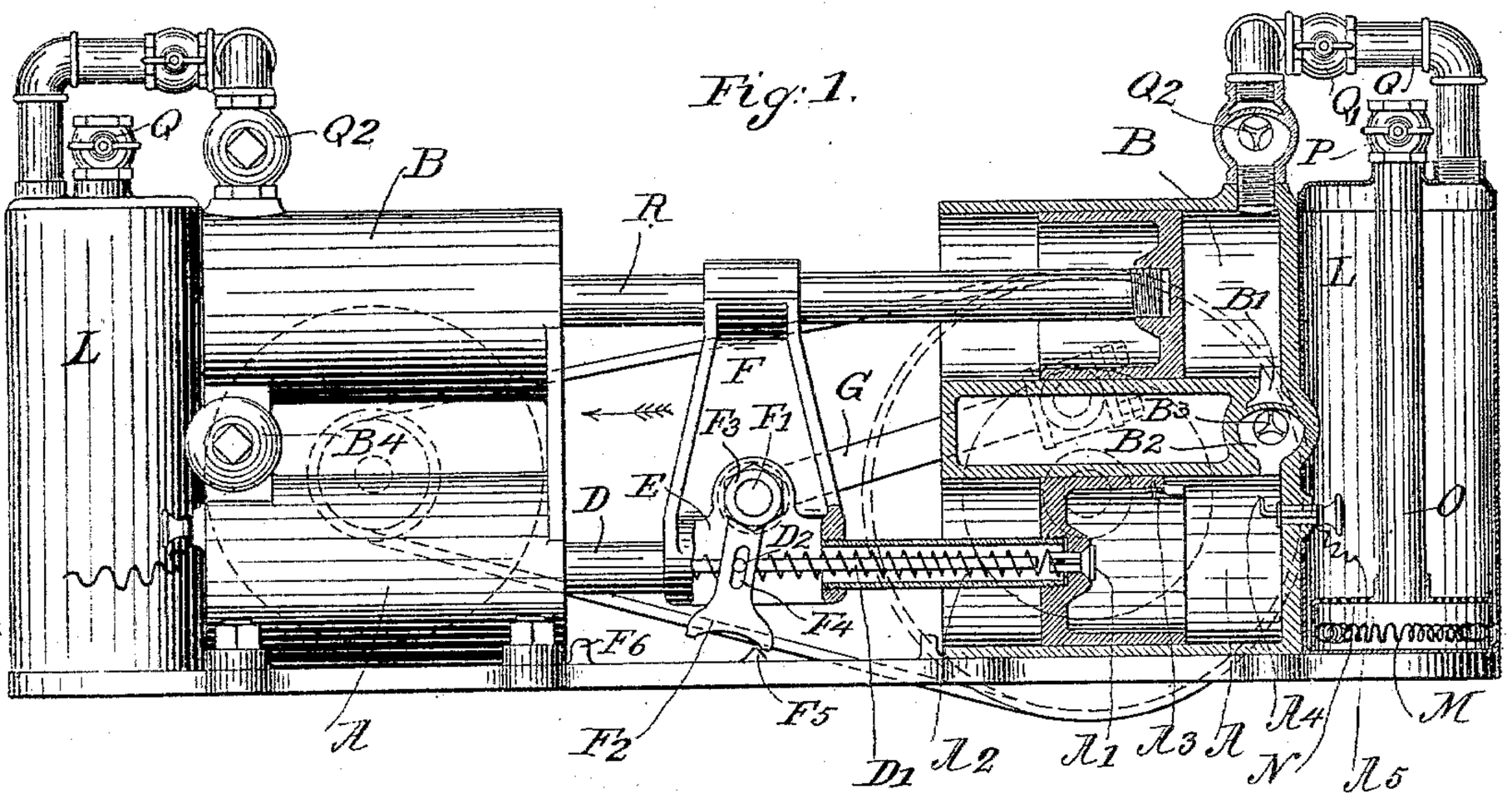
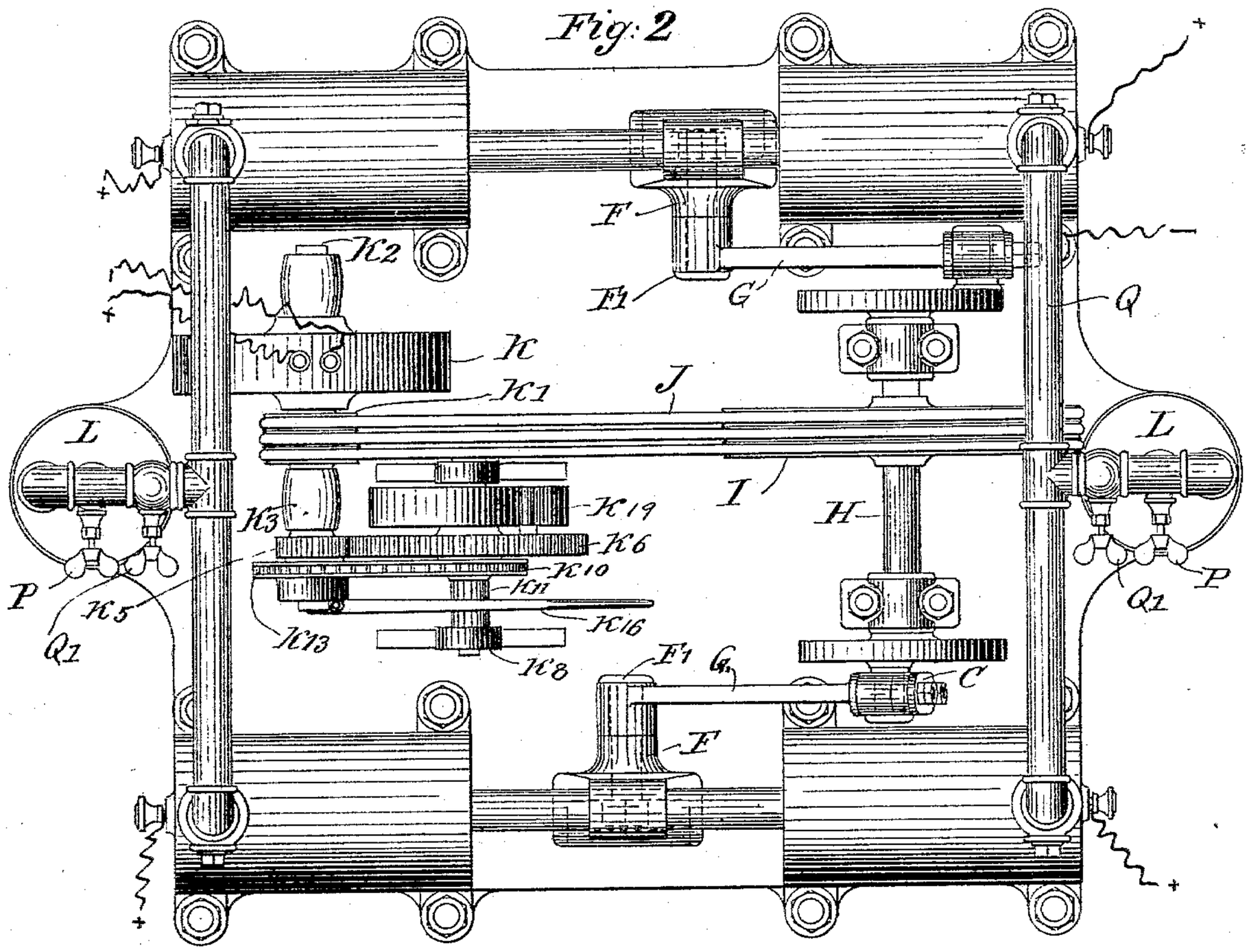


Fig. 2.



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(No Model.) 2 Sheets—Sheet 2.

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Fig: 4.

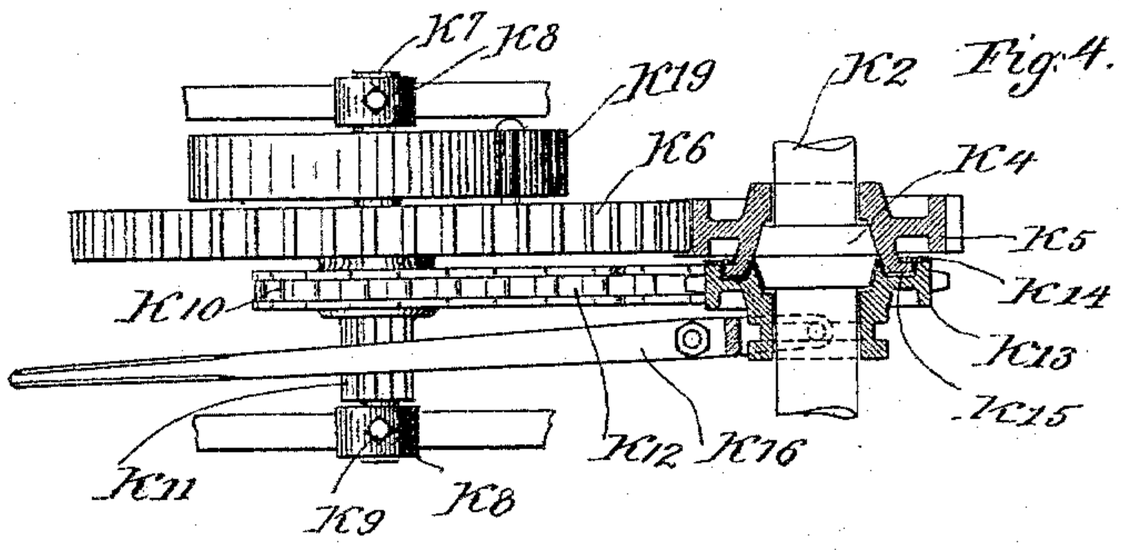


Fig: 5.

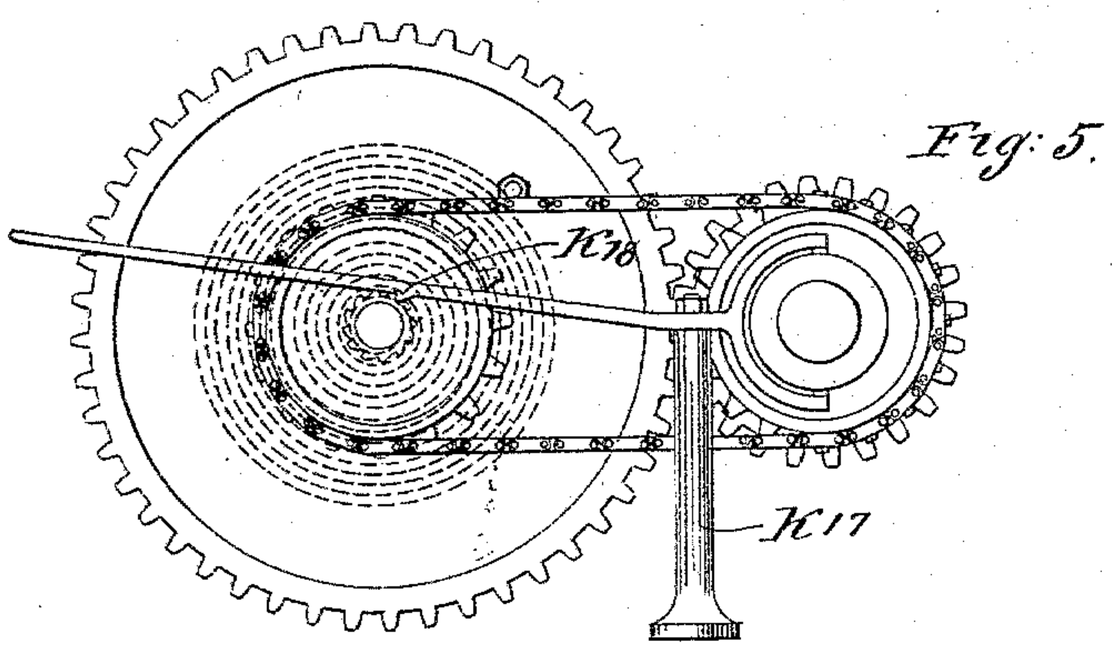
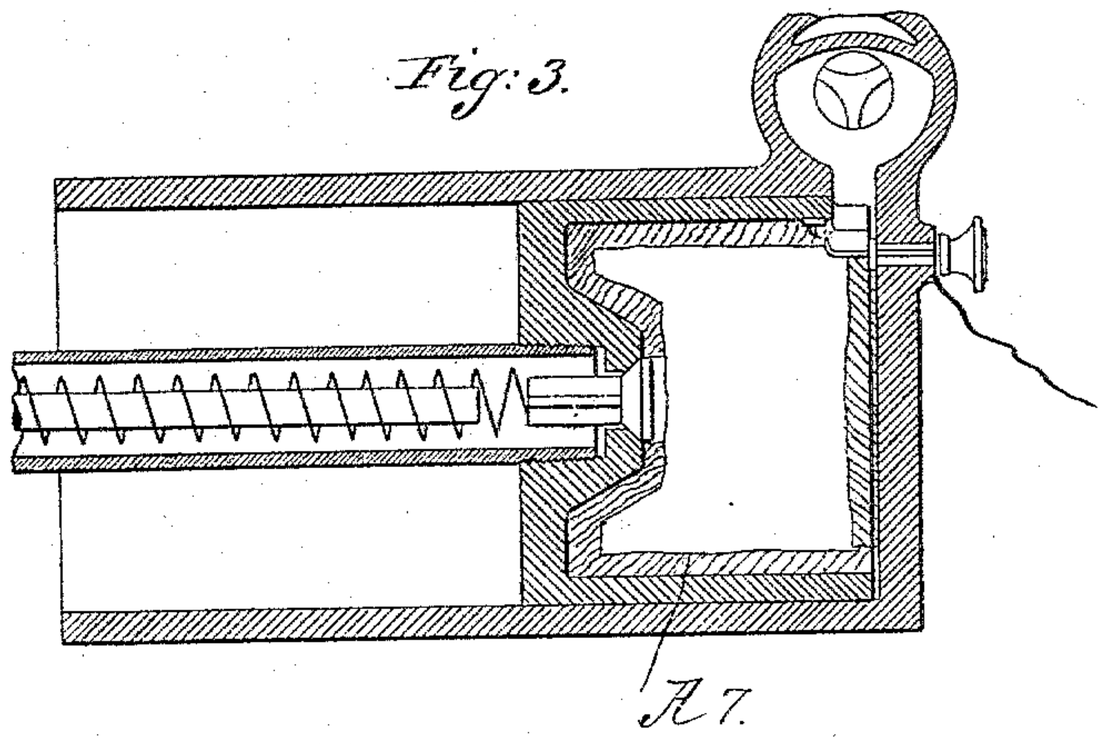


Fig: 3.



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UNITED STATES PATENT OFFICE.

ELIAS DUDLEY STRONG, OF CHICAGO, ILLINOIS.

EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 597,921, dated January 25, 1898.

Application filed January 25, 1897. Serial No. 620,680. (No model.)

To all whom it may concern:

Be it known that I, ELIAS DUDLEY STRONG, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Explosive-Engines, of which the following is a specification.

The object of my invention is to produce an engine having the special merits more particularly described and set forth in the specification and claims hereof.

Reference will be had to the accompanying drawings, in which—

Figure 1 is a side view of my engine with one end of the same in section. Fig. 2 is a plan view thereof. Fig. 3 is a detail sectional view of one of the explosion-cylinders in the position at the point of the ignition of the charge. Fig. 4 is a plan view, a part of which is in section, of the devices used in starting the engine. Fig. 5 is a vertical side view of the parts shown in Fig. 4. Figs. 4 and 5 are shown in reverse position to that which they occupy in Figs. 1 and 2.

My engine is constructed with four explosion-cylinders A and four compression-cylinders B, arranged as shown in the drawings. The pistons of the cylinders at one end are connected to the pistons of the corresponding cylinders at the other end by a rigid rod, and in the case of the compression-cylinders B the rods R are solid, while in the case of the explosion-cylinders the rods D are hollow and are open to vertical cavities E in the blocks F, and the exhausts from the explosion-cylinders pass out through the hollow rods D and out through the vertical slots or cavities E in the blocks F to the open atmosphere. The blocks F rigidly connect the rods R and D to each other in such a manner that the movement of the pistons connected to rod D moves also the pistons connected to rods R. To the blocks F, at the points F′, there are connected the main rods G, which are connected to cranks C, fixed on a shaft H, carrying the sheave-pulley I, driving the ropes J, driving the dynamo K. The connections of the cranks C to the pistons are made at ninety-degree angles to each other, in the ordinary manner of a double-cylinder engine. At each end of the engine there is provided a carbureter L for converting the oil into gas for the use of the engine. These carbureters are alike in construction and are designed to convert heavy oils into gas for use in the engine, and they consist of chambers in the bottom of which there is an electric coil M of bare wire through which the current of electricity passes, of such a quantity as to heat the wire and thereby heat the oil contained in the carbureter. No oil is here shown in the drawings. Covering the electric coil in the carbureters there is a perforated disk or cover-plate N, connected to a pipe O, which rises up through the oil, and to the atmosphere, and is provided with a regulating-valve P, through which all air must pass which is to mix with the oil and pass to the engine. Out from the main chamber of the carbureter there extends the pipe Q, provided with a valve Q′ and a check-valve Q^2, controlling the passage-way to the compression-cylinders B. Thus by the suction of the pistons of the cylinders B the air is drawn down through the pipe O and mingles with the oil in close proximity to the heating-coil M and rises up through the oil to the pipe Q, and thence to the cylinders B, and is prevented from flowing back during compression in the cylinders B by the check-valves Q^2.

The cylinders B are connected to their corresponding combustion-cylinders A by the ports B′, passing through the valve-chambers B^2, in which there are check-valves B^3. The check-valves B^3 are held shut against the exit of the gas from the cylinders B′ by coil-springs underneath the caps B^4, (shown at the left side of the drawing in Fig. 1,) the purpose of which is to retain the gas in the cylinders B during compression until such time as the compression of the gas shall overcome the strength of the spring, which is intended to be regulated to occur at a point corresponding to the position of the pistons shown in the drawings, but in which position the cylinders at the left side are intended to be under compression in the view as shown. The cylinders at the right-hand side are shown in section and in the position they are intended to assume during the period of explosion in the cylinders A and during the intaking of gas in the cylinders B.

The cylinders B are virtually no more or no less than ordinary pumps for forcing the

gas into the explosion-cylinders A at the required pressure, and the valves for the cylinders B are simply check-valves Q^2 and B^3, operated by the action of the gas. The exhaust-valves for the cylinders A are designated by A′, which are held to their seats by the tension-springs A^2 at all times, save when the rods D′ engage the stems of the valves A′ and forcibly hold them open. At one end of the crank-pins F′ there are held rocker-arms F^2, which are held upon the pin in frictional contact with a shoulder on the block F by nuts F^3. In the blocks F^2 there are slots F^4, engaging projections D^2 on the rods D′. The rocker-arms F^2 are intended to be clamped to the block F by friction sufficient to overcome entirely the strain of the spring A^2 upon the rods D′, since the springs A^2 are connected to projections D^2 and to the valve-blocks A′ and serve at all times to draw the two together.

Upon the bed of the frame there are projections F^5, which in the movement of the blocks F engage the arms F^2 and thereby move the rods D′, and in doing this the arm F^2 is moved by the projection F^5, overcoming the friction of the arm F^2 with the block F. This movement takes place in one direction or another every time the arms F^2 pass the centers of the stroke. In the drawings, Fig. 1, as shown, the further movement of the pistons in the direction of the arrow causes the rods D′ to move back, permitting the exhaust-valves on the left-hand side of the engine to close; but this movement is not yet sufficient to cause the exhaust-valves on the right-hand side of the engine to open. Then during the further movement of the pistons to the left in the direction of the arrow the charges in the cylinders at the left are compressed, but the charges in the cylinders at the right are not yet exhausted; but at the final completion of the stroke to the left the arms F^2 come in contact with the projections F^6 and cause the further movement of the rods D′ to the right, which further movement causes the rods D′ to engage the valve-blocks A′ and open them to exhaust the cylinders A, and these exhaust-valves of cylinders A are held open by the friction of the movement of the arms F^2 above mentioned by holding the rods D′ in place until such time that on the return stroke the arms F^2 will engage the projections F^5 at the center of the stroke and thereby withdraw the rods D′ sufficient to let the valves A′ close. The point of the completion of the closing of the valves A′ on the return stroke is designed to be the point of sufficient compression in the cylinders B to overcome the spring of the check-valves B^4 and thereby permit the gas to escape from the cylinders B into cylinders A. Upon the completion of the return stroke of the pistons in the cylinders A the points A^3 come in contact with the points A^4, thereby making a closed circuit for the electric igniter-wire A^5, and on the separation of the points A^3 and A^4 an electric spark takes place, igniting the charge. The other wire of the electric igniting-circuit is connected to the bed of the engine, and hence is at all times in circuit with the points A^3.

The pistons of the cylinders A are made in the form shown (see Fig. 3) in order that the flames at the point of combustion shall come in contact with the metal of the pistons and not in contact with the smooth sliding surface of the cylinders, which is a great desideratum, as the excessive heat, at the point of ignition, is prevented from coming in contact with the lubricated surface of the cylinders, and to lessen the quantity of heat that is imparted to the pistons I line them with asbestos, as is shown by A^7, Fig. 3.

It is always more or less difficult to start an engine of this class, and I provide a special apparatus for this purpose. The dynamo K is driven by the sheave-pulley K′ on shaft K^2, which carries the armature of the dynamo and extends beyond the bearing K^3, whereat there is connected the mechanism for starting the engine. (See Figs. 4 and 5.) Fixed on this shaft there is a double conical friction-disk K^4, and on one side thereof there is a pinion K^5, engaging the gear-wheel K^6, which gear-wheel K^6 revolves loosely on shaft K^7, supported in bearings K^8 from the bed of the engine, and shaft K^7 is held rigidly in bearings K^8 by set-screws K^9. Cast to the hub of the gear K^6 or fixed there in any suitable manner is a sprocket-wheel K^{10} and a ratchet-wheel K^{11}. The gear K^6, sprocket K^7, and ratchet K^{11} are fixed rigidly together and revolve loosely on shaft K^7. The sprocket-wheel K^{10} is connected by a sprocket-chain K^{12} to a sprocket K^{13}, which revolves loosely on shaft K^2 and is connected to gear K^5 by a ring K^{14} and flange-piece K^{15} in a manner that the sliding movement of the sprocket K^{13} on shaft K^2 carries with it the gear K^5, and at the same time permits gear K^5 to revolve independently on sprocket K^{13}. Gear K^5 and sprocket K^{13} are each provided with a conical friction-bearing suited to engage the friction-disk K^4, and thereby drive it or be driven by it. To the sprocket K^{13} there is provided a lever K^{16}, pivoted in a post K^{17} from the frame, and this lever is provided with a projection K^{18} for engaging the ratchet K^{11}. Fixed to the gear K^6 there is a coil-spring K^{19}, which has its other end fastened rigidly to shaft K^7.

The operation of the device is thus: The engine is started by hand the first time and is assumed to be in motion, the lever K^{17} holding the gear K^5 and sprocket K^{13} in position not to engage the friction-disk K^4 and permitting it freely to revolve, and thereby not impede the movement of the engine, but at any time desired the operator moves the lever K^{16} to bring the gear K^5 into engagement with the disk K^4, thereby causing the engine to revolve gear K^5 and wind up the spring K^{19}, the ratchet K^{11} and projection K^{18} acting to prevent the unwinding of the spring, and when the spring K^{19} is wound up the lever K^{16}

releases the disk K^4 from further winding of the spring. Then when the engine is at rest and it is desired to start it the lever K^{16} is thrown over, bringing the sprocket K^{14} in engagement with disk K^4, and when that engagement is secure the outer end of the lever is lifted slightly, causing the projection K^{18} to free the ratchet K^{11}, whereupon the spring K^{19} is permitted to act, and through the medium of the sprockets K^{10} and K^{13} the shaft K^2 is rapidly revolved, turning the engine and thereby starting it. Thus a force is stored up in the spring by the engine when it is moving to start the engine from a position of rest.

The engine is governed by throttling the gas either at the valves P or Q' or by the use of both valves, depending somewhat on the character of the gas used.

The electric heating apparatus for the oil in the carbureters is a desideratum, for with it a quality of oil may be used that can be used under no other conditions.

The separate compression-chambers for the gas provide for an explosion of the engine at every stroke of each piston, and the cylinders at each end of the piston-rods provide an explosion in each direction of the movement of the pistons, so that the momentum of the fly-wheel is not required to do any work at any time, and the peculiar construction of the pistons whereby the combustion of the gases takes place in contact with the asbestos lining of the pistons and not in contact with the lubricated surface of the cylinders is a great desideratum, since it preserves the cylinders and prevents excessive heat.

The arrangement of the compression-cylinders B in conjunction with the valves for the explosion-cylinders provides for the entry and compression of the gases in the explosion-cylinders in a more economical manner than by other methods.

What I claim is—

1. The combination of two combustion-cylinders and compression-cylinders arranged at opposite ends of single piston-rods, as shown, with exhaust-valves for the combustion-cylinders arranged in the pistons thereof, and springs for holding the exhaust-valves normally closed, and a rod sliding within a cavity in the piston-rod for positively opening the exhaust-valves, substantially as shown and described.

2. The combination of two combustion-cylinders arranged at opposite ends of a piston-rod, of a hollow piston-rod connecting the pistons of the two cylinders through which the exhaust passes out to the open air, of exhaust-valves arranged in the pistons, of springs for holding the exhaust-valves normally closed, with a rod mounted to slide within the hollow cavity of the piston-rod, and connected to a rocker-arm, which rocker-arm is normally held in a fixed position by a friction-bearing, and is positively moved, and thereby actuates the rod to open the exhaust-valves by stops fixed to the engine-bed, with which the said arm engages in its movement with the piston-rod, substantially as shown and described.

3. The combination of two cylinders arranged at opposite ends of a piston-rod for the purpose described, with a hollow piston-rod, through which the exhaust from the cylinders passes, of exhaust-valves arranged in the pistons normally held closed by springs, of a rod sliding within the hollow cavity of the piston-rod for positively opening the exhaust-valves, said rod held in a fixed position in relation to the pistons by frictional resistance, and actuated by positive stops at two intervals of each stroke in either direction, whereby at one interval the exhaust-valve at one end is permitted to close before the exhaust-valve at the other end is opened, combined and arranged, substantially as shown and for the purpose described.

4. A starting device for an engine of the class described, the combination of a friction-gearing connected to be driven, or in turn to drive the engine, of a pinion mounted in a manner to be driven by the friction-gearing, of a gear engaging the said pinion with a coil-spring connected to the gear, and to a fixed point whereby the revolution of the gear winds up the coil of the spring, in the manner shown, with a sprocket-wheel and ratchet mounted to revolve with the gear and a sprocket-chain driven by said sprocket, and driving another sprocket, which latter sprocket is mounted in a manner suitable to engage by friction and drive the friction-gearing before mentioned, and hence the engine, and suitable means for engaging and disengaging said friction-gearing and ratchet in the manner shown, and for the purpose described.

5. The combination of four explosion-cylinders, arranged in rectangular form upon a bed-plate in sets as shown, of hollow piston-rods connecting the pistons of each set, valves within the piston-rods for controlling the exhaust from the cylinders through the rods: of a compression-cylinder for each of the explosion-cylinders, arranged in the same vertical plane with its explosion-cylinder, the pistons of the compression-cylinders of each set having a common piston-rod, and connected by a block with the piston-rod of the explosion-cylinders, pitmen connecting the blocks of the piston-rods with cranks arranged upon a shaft at different angular positions with each other, combined and arranged substantially in the manner shown and for the purpose described.

In witness whereof I have hereunto subscribed my name, on this 22d day of January, 1897, in the presence of two subscribing witnesses.

ELIAS DUDLEY STRONG.

Witnesses:

HERBERT MURPHY,

JAS. H. ZEARING.