No. 816,062. PATENTED MAR. 27, 1906.

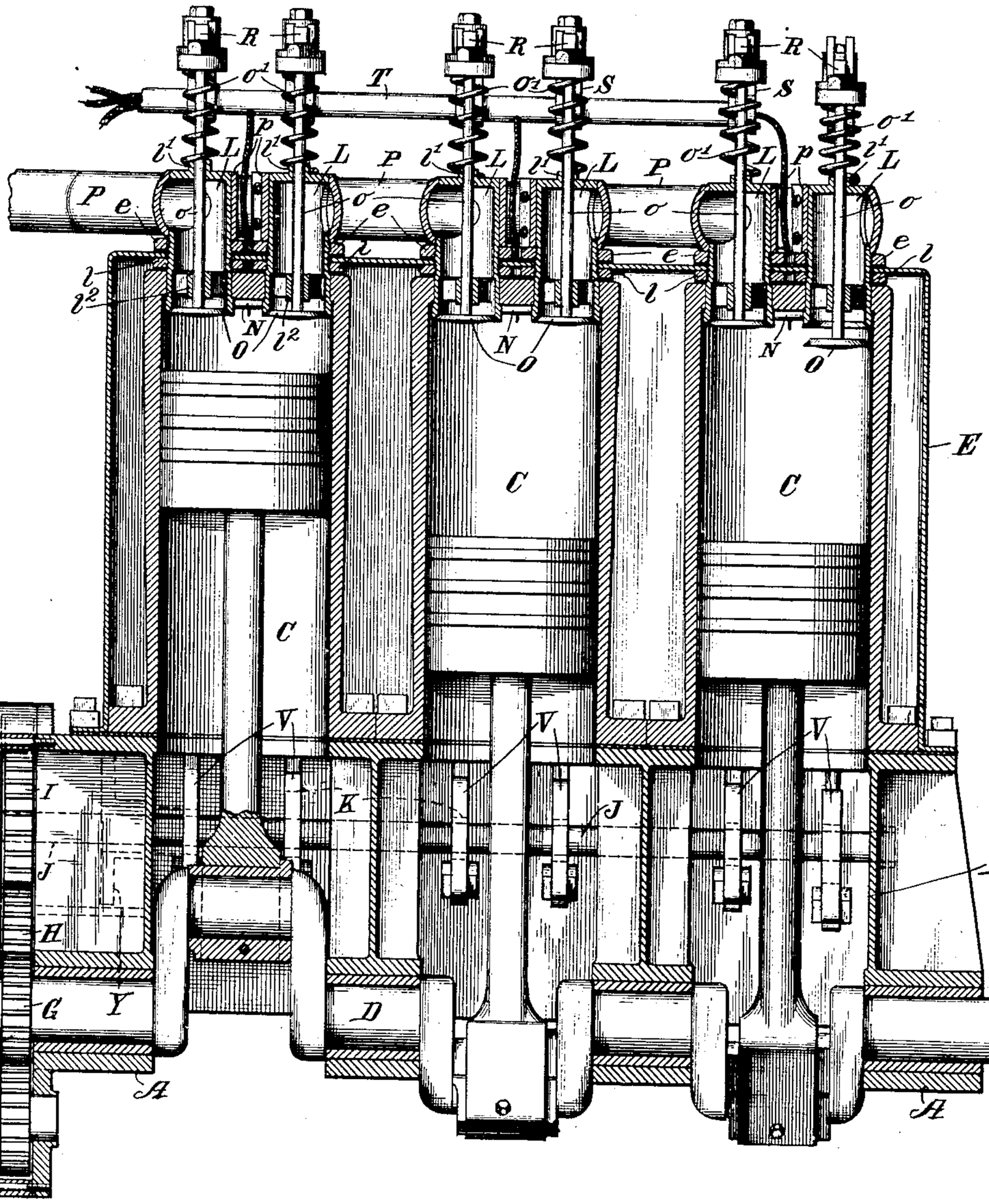
I. S. BARNETT.

GAS ENGINE.

APPLICATION FILED FEB. 6, 1904.

3 SHEETS—SHEET 1.

Fig. 1.



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3 SHEETS—SHEET 2.

Fig. 2.

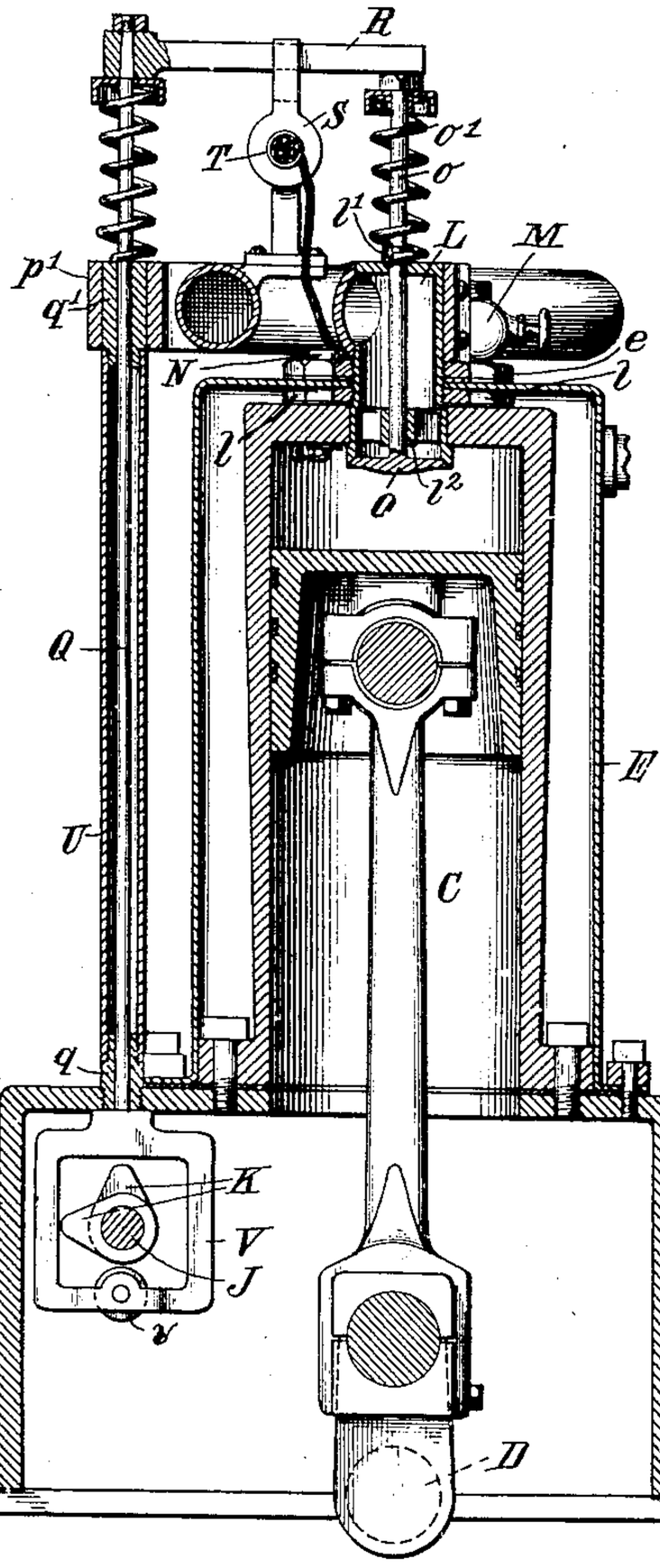


Fig. 3.

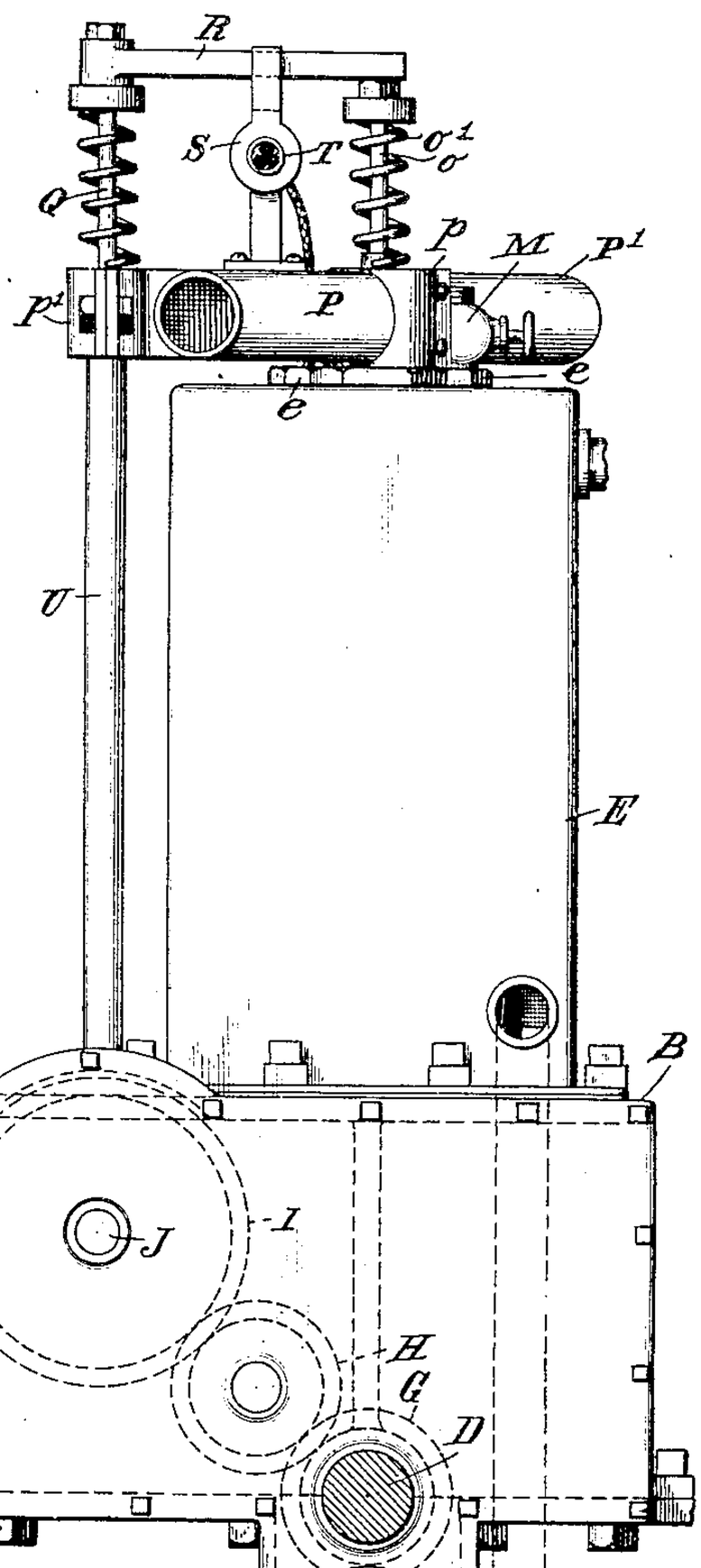


Fig. 5.

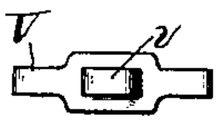
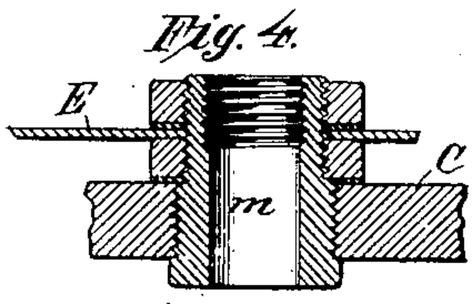


Fig. 4.



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3 SHEETS—SHEET 3.

Fig. 6.

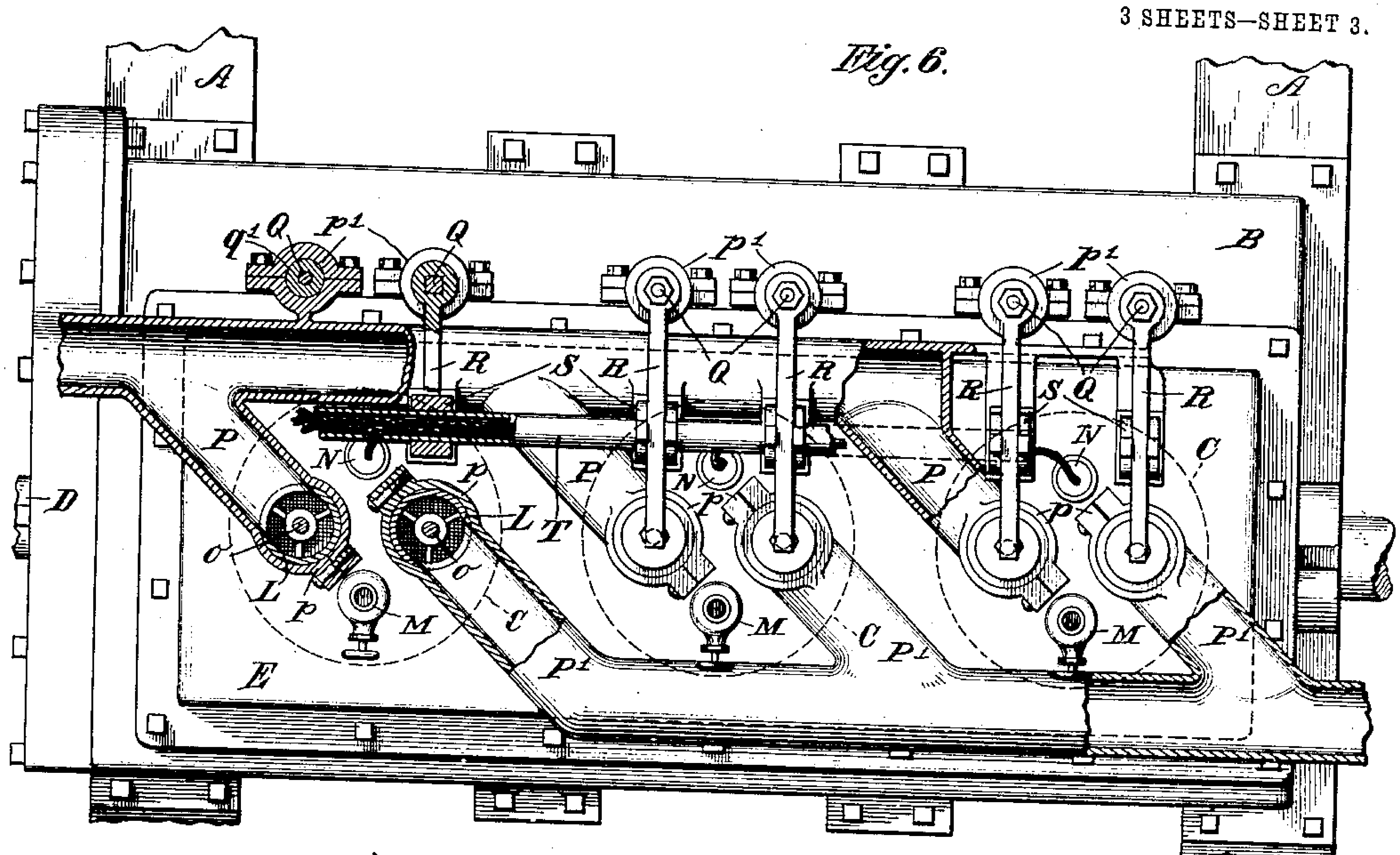


Fig. 7.

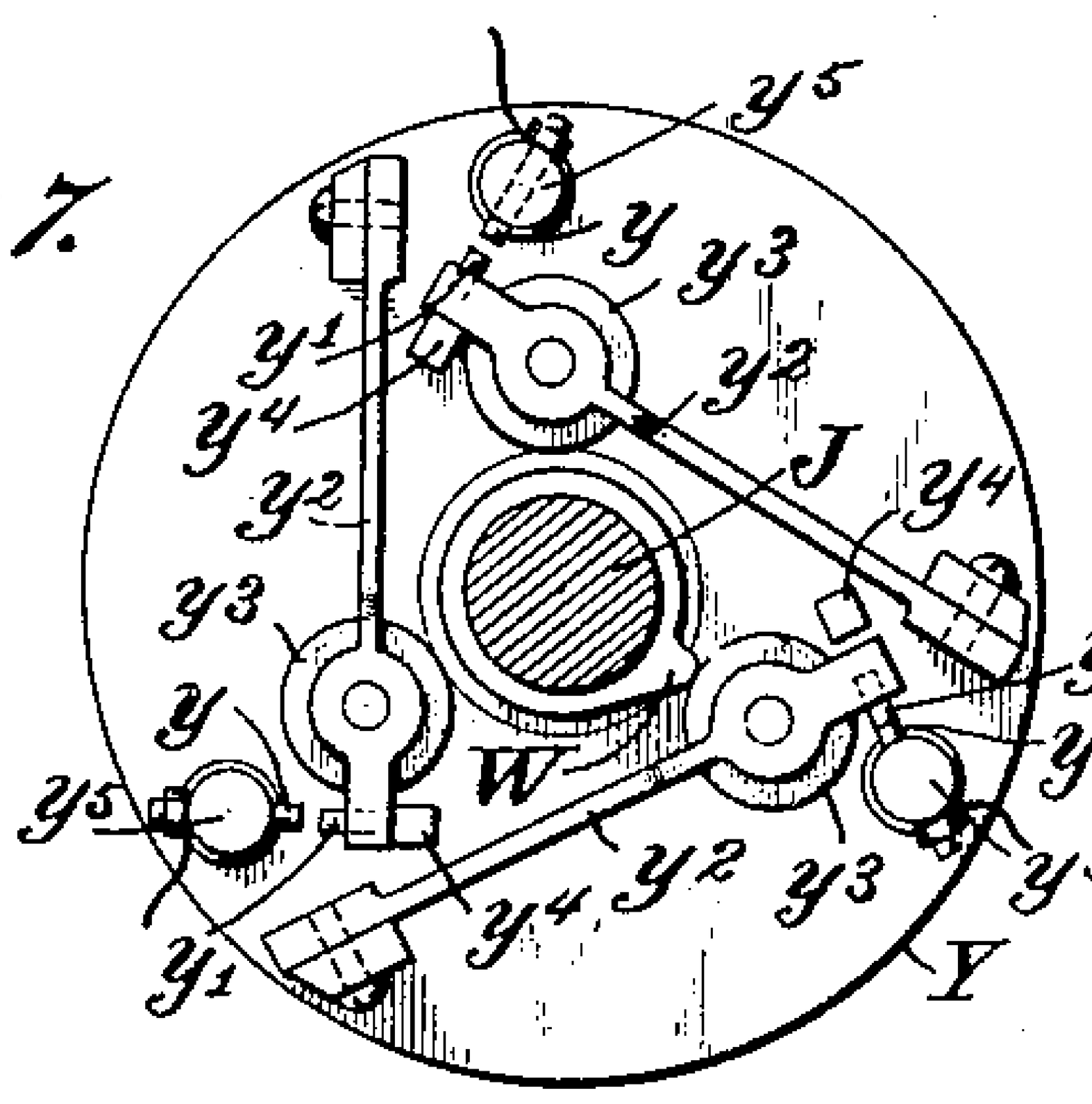


Fig. 8.

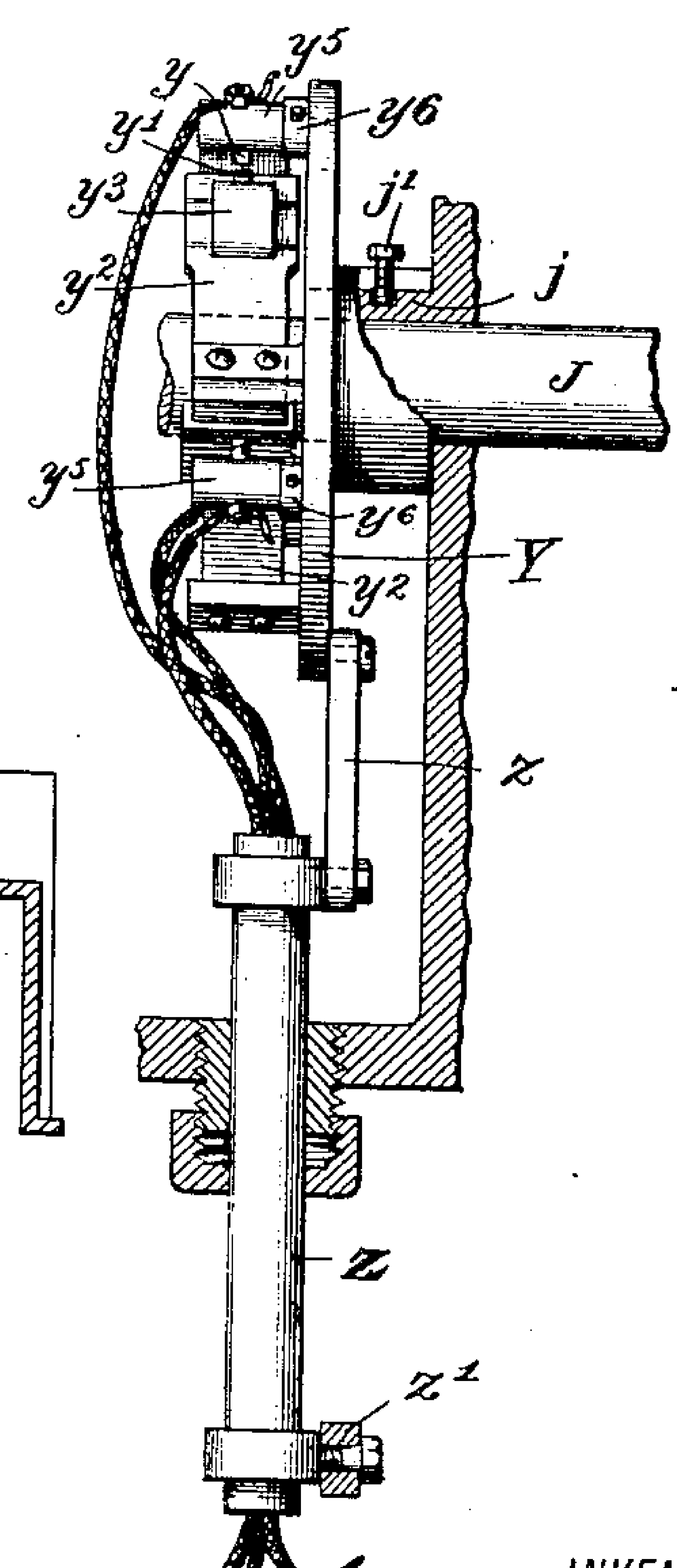
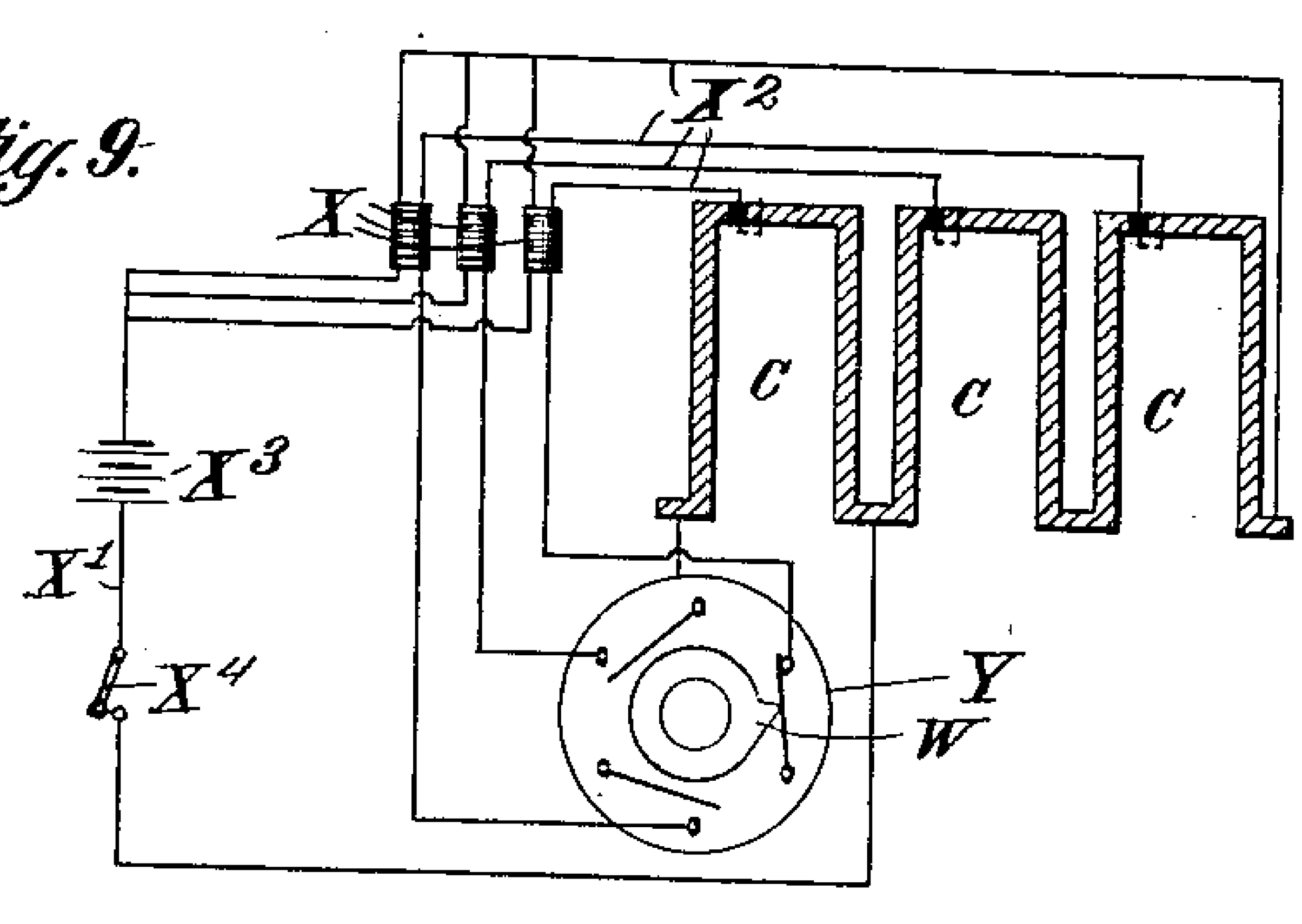


Fig. 9.



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UNITED STATES PATENT OFFICE.

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GAS-ENGINE.

No. 816,062. Specification of Letters Patent. Patented March 27, 1906.

Application filed February 6, 1904. Serial No. 192,410.

To all whom it may concern:

Be it known that I, IRA SAYRE BARNETT, a citizen of the United States, residing at Louisville, in the county of Jefferson and State of Kentucky, have invented certain new and useful Improvements in Gas-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 appertains to make and use the same.

This invention relates to gas-engines and other explosion or internal-combustion motors employing gaseous or liquid combustibles—such as gas, gasolene, oil, naphtha, or admixtures thereof with air—for the motive charges.

My improved engine embodying such invention is of special value as a motor for automobiles or motor-vehicles and has been designed largely for that purpose, simplicity and compactness of construction and lightness of weight having been important factors kept in view in evolving the invention. The engine is, however, applicable to any service.

In addition to securing a motor of high efficiency combined with simplicity, compactness, and lightness of construction, as above noted, the principal objects of the invention are, first, to produce an improved construction and arrangement of valves adapted to the requirements of engines of this class; second, to provide improved valve-operating mechanism of simple and strong construction and positive action; third, to devise improved means for automatically igniting the explosive charges in the working cylinder or cylinders and to provide for adjustment thereof for regulating the periods or times of ignition, and various minor objects hereinafter appearing, all aiming to improve the construction and efficiency of machines of this character.

The invention will first be described with reference to the accompanying drawings, which are to be taken as a part of this specification, and will then be defined more particularly in the annexed claims.

In said drawings, wherein corresponding parts in the several views are designated by like characters of reference, Figure 1 is a central longitudinal vertical section of a gas-engine embodying my invention. Fig. 2 is a vertical cross-section of the same. Fig. 3 is a front elevation of said engine. Fig. 4 is a detail sectional view of a fitting in the cylinder-head for a spark-plug, blow-off cock, or the like. Fig. 5 is a detail bottom plan view of the roller-carrying frame of one of the valve-operating rods. Fig. 6 is a top plan view of the engine with parts in section. Fig. 7 is a front elevation of my improved contact-breaker or make-and-break device for the circuits of the electric igniting apparatus. Fig. 8 is a side view of said device, showing the same in its compartment. Fig. 9 is a diagrammatic representation of the engine and electric igniting apparatus including the circuits, induction-coils, make-and-break device, &c.

The engine illustrated in the drawings is a triple-cylinder motor, each working cylinder of which is of the ordinary four-cycle type; but the invention is of course equally applicable to a single-cylinder, two-cylinder, or other multiple-cylinder machine.

Referring to said illustrated machine by symbols of reference, the letters A A designate transverse supports on which the engine-bed B is mounted. These supports may be bolted rigidly to the frame of the automobile or other machine in which the engine is to be used.

The letters C C C indicate the working cylinders, shown mounted vertically upon the engine-bed, having their lower ends open and their upper ends closed. The engine-shaft D, mounted in suitable bearings in the engine-bed or, as here shown, in bearings formed between the engine bed and supports A, is represented having three cranks disposed at different angles and connected by pitmen, with suitable pistons working in the respective cylinders.

In practice the cylinders are preferably economically constructed from steel castings or forgings bored inside in the usual manner and turned down outside to give proper thickness for strength and having suitable openings in their heads for inlet and exhaust valves, spark-plugs, and blow-off cocks. It will be noticed that the cylinder-walls are represented here tapering downwardly in thickness, greater strength being required at their upper ends where the explosions occur. The lower open ends of the cylinders have flanges bolted to the engine-bed, suitable gaskets being preferably interposed to form water-tight joints.

Surrounding all the cylinders is a water-

jacket E, of sheet-copper or other appropriate material, having a bottom flange bolted to the upper plane surface of the engine-bed, a suitable gasket being preferably interposed. This jacket completely incloses the cylinders, which are turned down and spaced apart, as stated, thus providing a large water-space and insuring an effective cooling. Circulation of water in the jacket is maintained by a pump, as F, having suitable inlet and discharge pipes communicating with the water-space. Cool water is pumped from the pump to the water-jacket, and thence the heated water is circulated to a cooling apparatus (not shown) and back to the pump, so that cool water is maintained in the jacket. The pump is shown located beneath the engine-shaft and operated directly from a gear G on the shaft. Said gear G is also shown geared, through the medium of an idler H, with a gear I on a counter-shaft J, mounted in a lateral extension of the engine-bed and having a series of cams K thereon for operating the valve-rods, as hereinafter explained.

Each cylinder-head is represented equipped with valve-casings L for the inlet and exhaust valves, cock M, and spark-plug N. The valve-seats are located practically within the explosion-chamber of the cylinder and formed in the lower ends of the cylindrical fittings or valve-casings L, fitted tightly in openings therefor in the cylinder-head, having lower shoulders held air-tight against the inner or lower side of the cylinder-head, asbestos gaskets being preferably interposed and having upper exteriorly-threaded parts engaged by nuts *l*, which secure the valve-casings firmly in place. These nuts form shoulders for the water-jacket, which rests thereon, has openings inclosing the valve-casings, and is held firmly down by other nuts *e*. Gaskets are preferably interposed between the nuts *l* and *e* and cylinder-head and water-jacket. The valve-casings extend somewhat above the water-jacket, have lateral openings communicating with the gas inlet and outlet pipes P and P′, closed upper ends with guides *l′* for the valve-stems *o* of the valves proper, O, and also lower guides *l²* for said valve-stems. The valves O, which preferably open within the cylinder, are held against their valve-seats by springs, such as coiled springs *o′*, inclosing the valve-stems between the tops of the valve-casings and nuts, caps, or other abutments on the valve-stems. The valves open by depression of their valve-stems, as hereinafter described. This arrangement of having the valves operate entirely within the cylinder is an advantage over other engines in that it dispenses with the separate combustion or explosion chambers common to motors of this type, causes the explosion to take place wholly within the cylinder, so that all its power is more effectively exerted in working the piston, and avoids generation of heat outside the cylinder, as in those engines wherein the gas is ignited in a separate chamber.

The blow-off cock M and spark-plug N are screwed or otherwise secured in fittings or short pipe-sections, such as *m*, secured in the cylinder-head and water-jacket in a similar manner to that in which the valve-casings L are fastened. As shown in Fig. 4, the said fittings *m* are screwed in the cylinder-head by left-hand threads, have shoulders held against the inner side of the head, and have right-hand nuts screwed thereon and binding the same in place. The water-jacket has openings inclosing the fittings and is held tightly down on said nuts by other nuts screwed on said fittings. Gaskets are preferably interposed between the lower nuts and cylinder-head and water-jacket to make water-tight joints. It is an advantage to have the spark-plug situated at the top of the cylinder in this way, since in such position it is less liable to come in contact with the cylinder-oil, and thus become short-circuited.

The inlet-pipe P supplies gas or explosive mixture to the cylinder, and the exhaust-pipe P′ discharges the spent gases therefrom. Said inlet-pipe communicates with any suitable source for supplying the explosive mixture, usually with a source of air-supply and also with an atomizer, carbureter, or other device (not shown) by means of which gasolene or other liquid combustible is vaporized and mixed with air for producing the explosive charges. The pipes P and P′, as shown, extend along opposite sides of the set of cylinders and have branches communicating with the valve-casings and fitted to the openings thereof by air-tight joints. The ends of the pipes are formed with clamps *p*, secured around the valve-casings, to make air-tight joints, which also support and secure the pipes firmly in place.

The mechanism for automatically opening the inlet and exhaust valves consists in the main of a series of vertically-movable valve-rods Q, operated by the cams K on the cam-shaft J and carrying lateral valve-operating arms or trippets R, adapted on descension of said rods to depress the valve-stems. Said rods are shown guided in bearings *q′* and *q* at their upper and lower ends, respectively, the upper bearings being supported in clamps *p′* on the pipe P and the lower ones consisting of bushings screwed into the engine-bed. Tubes U, screwed to the bearings *q′* and *q*, form housings for the rods, hold the upper bearings against vertical movement, and render the structure more rigid. The valve-operating arms or trippets R are rigidly secured on the upper ends of the valve-rods, and they may be held so as to project directly over the valve-stems by guides mounted on the pipe P. These guides are shown as the upper bifurcated ends of standards S, which have also

mountings or settings for a tube T, which incloses electric wires of the sparking or igniting circuit, hereinafter described. The valve-rods are held normally raised by suitable springs, such as stout coiled expansion-springs q^2, inclosing the rods and acting between the upper bearings q' and suitable caps or other abutments on the rods. At their lower ends the rods are formed or provided with rigid frames V, each inclosing one of the cams K and carrying a lower roller v beneath the cam, adapted to be engaged thereby to lower the rod on each revolution of said cam. The said frames are preferably formed with shoulders around their junctions with the rods, which limit their upward movement and stop the rollers from touching back of the cams, so that said rollers will be engaged only by the projecting or raised parts of the cams at the proper intervals. The cam-shaft J, as before mentioned, is geared to the engine-shaft D through the medium of gears G H I. Gear I has twice as many teeth as the gear G, and hence the cam-shaft J, known as a "one-to-two" shaft in the trade, rotates but once for every two rotations of the engine-shaft. The several cams K are set on the cam-shaft in such position as to engage the rollers v at the proper times and for the proper intervals to open and release the inlet and exhaust valves for the proper periods, and since the engine-shaft rotates twice to every rotation of the cam-shaft it is obvious that the inlet and exhaust valves of each cylinder each open once for every two reciprocations of the piston of that cylinder, which is proper in a four-cycle engine. The position or adjustment of the several cams determines, of course, the periods of opening and closing of the corresponding valves, and as the proper periods for introduction of the explosive charges and exhaust of the spent gases are well understood further explication is deemed unnecessary.

I have illustrated herein electrical sparking or igniting apparatus which, so far as the general electrical circuits are concerned, is common to many explosion-engines; but the make-and-break devices for such circuits constitute an important and valuable feature of my invention. The spark-plug N of each cylinder-head holds one terminal of the electrical circuit for that cylinder, the other terminal of which connects with the ironwork of the motor or with the cylinder, and thus completes the circuit through the spark-plug. As usual in electrically-ignited explosion-engines, I preferably employ for each cylinder an induction-coil X, the primary circuit X′ of which includes a battery X^3, switch X^4, and contact-breaker or my improved automatic make-and-break device Y, and the secondary circuit X^2 of which has its opposite terminals connected to the spark-plug N and ironwork of the motor or cylinder, as before noted. The electrical circuits and connections are diagrammatically represented. As the illustrated machine is a triple-cylinder engine, there are indicated three of the induction-coils X, or "sparking coils," as they are usually called, from the secondary poles of each of which one wire leads to the spark-plug N and the other connects with the ironwork of the motor. From the primary poles of each induction-coil one wire leads to the battery X^3, while the other leads to the contact-breaker or make-and-break device Y, which, together with the ironwork of the engine, is in the primary electrical circuit, said circuit also including the switch X^4, common to all the circuits. The wires of all the secondary circuits X^2 may be suitably insulated and inclosed in the aforementioned tube T, which is preferably filled with wax or other suitable substance to prevent water or moisture from seeping through the tube, as well as to prevent the wires from contacting or becoming short-circuiting in any way.

The make-and-break device, commonly called the "breaker-box," is preferably inclosed in a dust-proof and water-tight compartment in the engine-bed. This is especially for the purpose of preventing water from reaching the contact-breaker and forming short circuits by accident or otherwise, as when the motor car or machine is run through a deep stream. With most automobiles when run through water as soon as the water reaches the contact-breaker the engine stops by reason of short-circuiting; but in the present machine such liability is avoided. The three wires leading from the induction-coils to the make-and-break device Y may be suitably insulated and inclosed in a tube Z, filled with wax or other suitable substance, and fitted in a water-tight stuffing-box in the wall of said compartment. Said make-and-break device Y consists, in the main, of a metal member, as a disk or plate, having a bearing around the cam-shaft J in contact with the ironwork of the engine or otherwise in the electrical circuit, having suitably-disposed insulated contact-points y connected to the terminals of the aforesaid wires X′ from the sparking coils and non-insulated contact-points y', carried by metal springs or spring-levers y^2 and held normally out of contact with said contact-points y, but adapted to be brought successively into contact therewith on each rotation of the cam-shaft J by a cam W on said shaft, adapted to engage said springs or rollers y^3, carried thereby. The springs or spring-levers y^2 are shown secured to suitable lugs on the face of the plate Y and having their free ends pressed inward against other stops or lugs y^4. The contact-points y, which are preferably adjustable screws, are secured in insulating-blocks y^5, of wood fiber or other appropriate material, shown in the form of

threaded plugs screwed into threaded recesses in lugs y^6. The free ends of the levers y^2 normally remain inward against the stops y^4; but as the cam W revolves it engages the three rollers y^3 in proper order and moves the contact-points y' into engagement with the contact-points y, thus making and breaking three circuits in each revolution, one circuit for every cylinder. There are two kinds of induction-coils, one known as the "vibrator" and the other as the "non-vibrator" coil. With the vibrator-coils as the contact-points y and y' of each circuit are brought into contact the primary circuit is energized, and at the same time the spark occurs in the cylinder and continues until the contact is broken: With the non-vibrator coils when the contact of the points y and y' of each circuit is broken the secondary circuit becomes energized, causing the current to bridge the gap in the cylinder and produce the spark by which the charge of explosive mixture is ignited. My igniting apparatus may be used with either kind of coils, though I prefer the non-vibrator coils. As the cam-shaft J rotates once to every two rotations of the engine-shaft, it follows that the sparks are produced in the cylinders at every second reciprocation of the pistons, which is proper.

The plate Y is preferably mounted on the bearing j of the cam-shaft to prevent unnecessary wear and friction. Its hub or central boss is shown rotatably fitted on said bearing and held thereon by a pin j', inserted through the hub into a slot or groove in the bearing. The plate is practically stationary, but is adapted to be oscillated or turned through a small arc for the purpose of adjusting the time of engagement of the cam W with the rollers y^3, and thus regulate the time at which the explosions occur in the cylinders. In starting the engine a late spark is needed—that is, the spark should not occur in each cylinder until the piston-rod or pitman in that cylinder has passed or overcome a dead-center. When the engine is in action, an earlier spark is desired, and for high speed a still earlier spark is necessary. This is effectively provided for by the above-mentioned oscillation or adjustment of the plate Y. As a means for turning said plate it is shown connected by a crank z with the tube Z, which slides through the stuffing-box in the walls of the contact-breaker compartment, said tube Z having suitable connection, as indicated at z', with a lever (not shown) for moving it a limited distance inward and outward.

From the foregoing description, taken in connection with the accompanying drawings, the operation of the engine will be readily understood and the advantages of the several features of novelty herein noted fully appreciated.

It will be understood, of course, that numerous changes may be made in the details of construction and general arrangement of parts without departing from the scope of my invention, and therefore I do not desire to be limited to the specific construction shown and described.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A gas-engine having, in combination, a plurality of upright cylinders arranged in alinement above a horizontally-disposed engine-shaft, pistons therein operatively connected to the engine-shaft, inlet and exhaust valves in the cylinder-heads, inlet and exhaust pipes disposed at opposite sides of the series of cylinders and communicating respectively with the inlet and exhaust valves, vertically-disposed rods having means for engaging and opening said valves, a shaft geared to the engine-shaft having a series of cams adapted at proper periods to actuate said valve-rods, electrical circuits having separate terminals in the cylinders for igniting the explosive charges, and a make-and-break device mounted on said cam-shaft connected with and adapted to make and break the several circuits in succession at the proper periods.

2. In a gas-engine, a cylinder having an opening in its head, a valve-casing fitted in said opening having an inner shoulder and an outer binding-nut screwed thereon, a water-jacket surrounding the cylinder seated against said nut and having an opening fitting around said valve-casing, and an outer nut screwed on said valve-casing against said water-jacket securing the parts in place.

3. In a gas-engine, a cylinder having openings in its head for valves, spark-plug, blow-off cock, or the like, valve-casings and fittings for such parts fitted in said openings and secured in place by inner shoulders and outer binding-nuts, a surrounding water-jacket seated against said nuts and having openings inclosing said valve-casings and fittings and other binding-nuts screwed on said valve-casings and fittings against said water-jacket.

4. A gas-engine having, in combination, a suitable bed, a cylinder having an open end secured thereto and an outer closed end or head, a working piston therein, an engine-shaft operatively connected to said piston, inlet and exhaust valves in the cylinder-head, inlet and exhaust pipes rigid with the cylinder-head and communicating with said valves, valve-operating rods arranged longitudinally of the cylinder, bearings therefor in the bed, bearings therefor supported by one of said pipes, tubes inclosing said rods and rigidly connected to said bearings, frames rigid with said rods spring-held against the opposite side of the bed, rollers carried by the far sides of the frames, a shaft passing through said frames geared to the engine-shaft to rotate once to every two ro-

tations of the latter, and cams on said shaft adapted to engage said rollers and thereby move the rods to open the valves at the proper periods.

5. A gas-engine having, in combination, a suitable bed, a cylinder having an open end secured thereto and an outer closed end or head, a working piston therein, an engine-shaft operatively connected to said piston, inlet and exhaust valves in the cylinder-head, inlet and exhaust pipes rigid with the cylinder-head and communicating with said valves, valve-operating rods arranged longitudinally of the cylinder, bearings therefor in the bed, bearings therefor supported by one of said pipes, tubes inclosing said rods and rigidly connected to said bearings, and means for moving said rods to open said valves at the proper periods.

6. A gas-engine having, in combination, an engine-bed, a plurality of upright cylinders mounted thereon having upper closed heads, working pistons therein, an engine-shaft operatively connected with said pistons, inlet and exhaust valves in the cylinder-heads, inlet and exhaust pipes arranged at opposite sides of the cylinder having branches communicating with the inlet and exhaust valves respectively and rigidly secured to the casings thereof, a series of vertically-movable valve-operating rods, upper bearings therefor supported by one of said pipes, lower bearings therefor in the engine-bed, tubes inclosing the pipes and rigidly connecting said bearings, and a shaft geared to the engine-shaft and properly timed having a series of cams thereon for operating said valve-rods.

7. A gas-engine having, in combination, a bed having bearings for a horizontally-disposed shaft, an upright cylinder rising therefrom having its working piston connected to said shaft, inlet and exhaust valves in the upper cylinder-head, vertical valve-operating rods, a counter-shaft also journaled in bearings in said bed geared to the engine-shaft and having means for controlling said rods, an electrical igniting-circuit, a make-and-break device therefor mounted on said shaft, and a water-tight compartment in said bed in which said make-and-break device is housed.

In testimony whereof I affix my signature in presence of two witnesses.

IRA SAYRE BARNETT.

Witnesses:

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GEO. BUECHEL.