N. DE LONG.

GAS ENGINE.

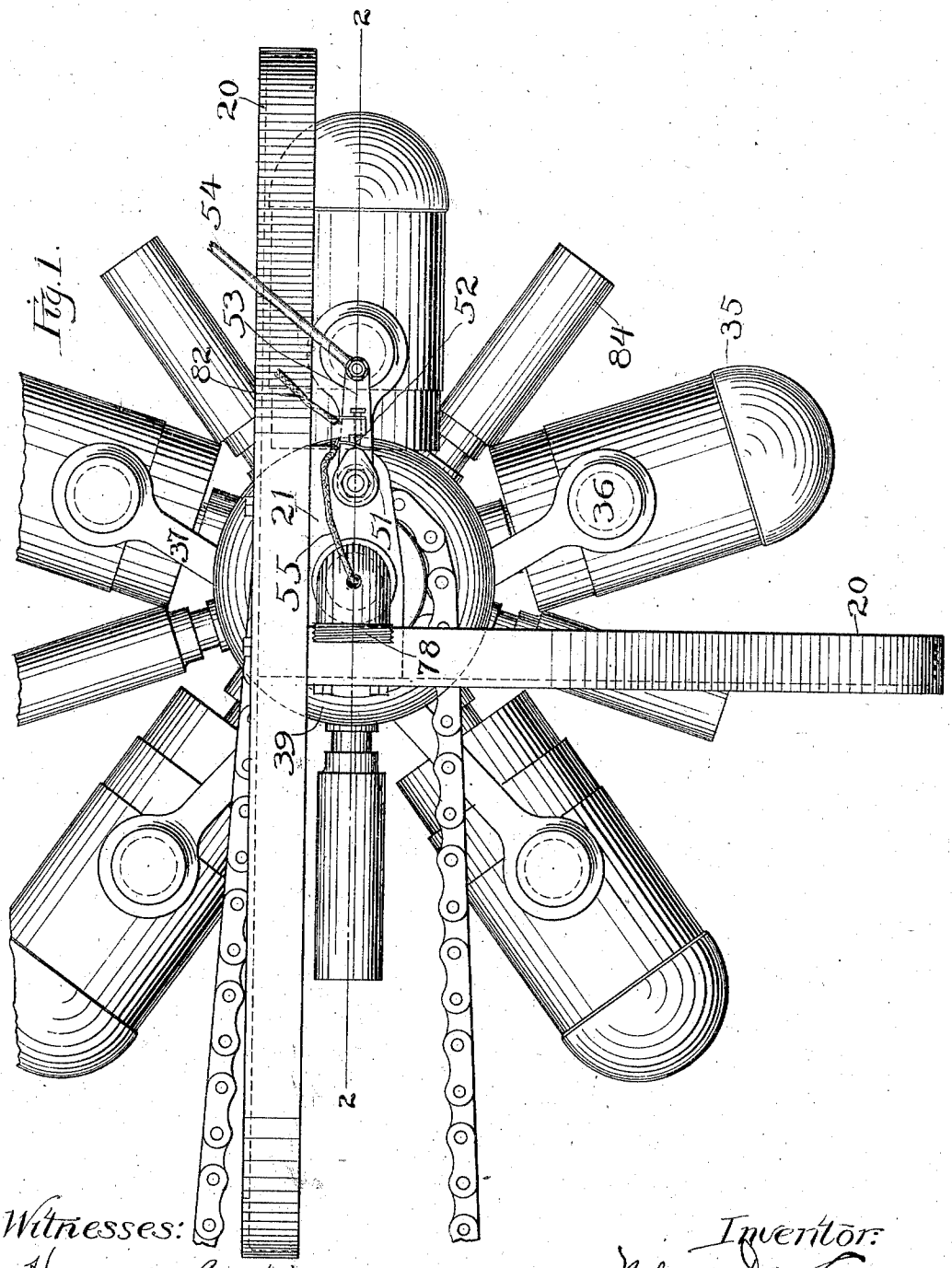
APPLICATION FILED JAN. 6, 1909.

967,735.

Patented Aug. 16, 1910.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
Howard A. Redfield
Walter A. Redfield

Inventor:
Nelson De Long
By Cooper L. Redfield
Attorney.

N. DE LONG.

GAS ENGINE.

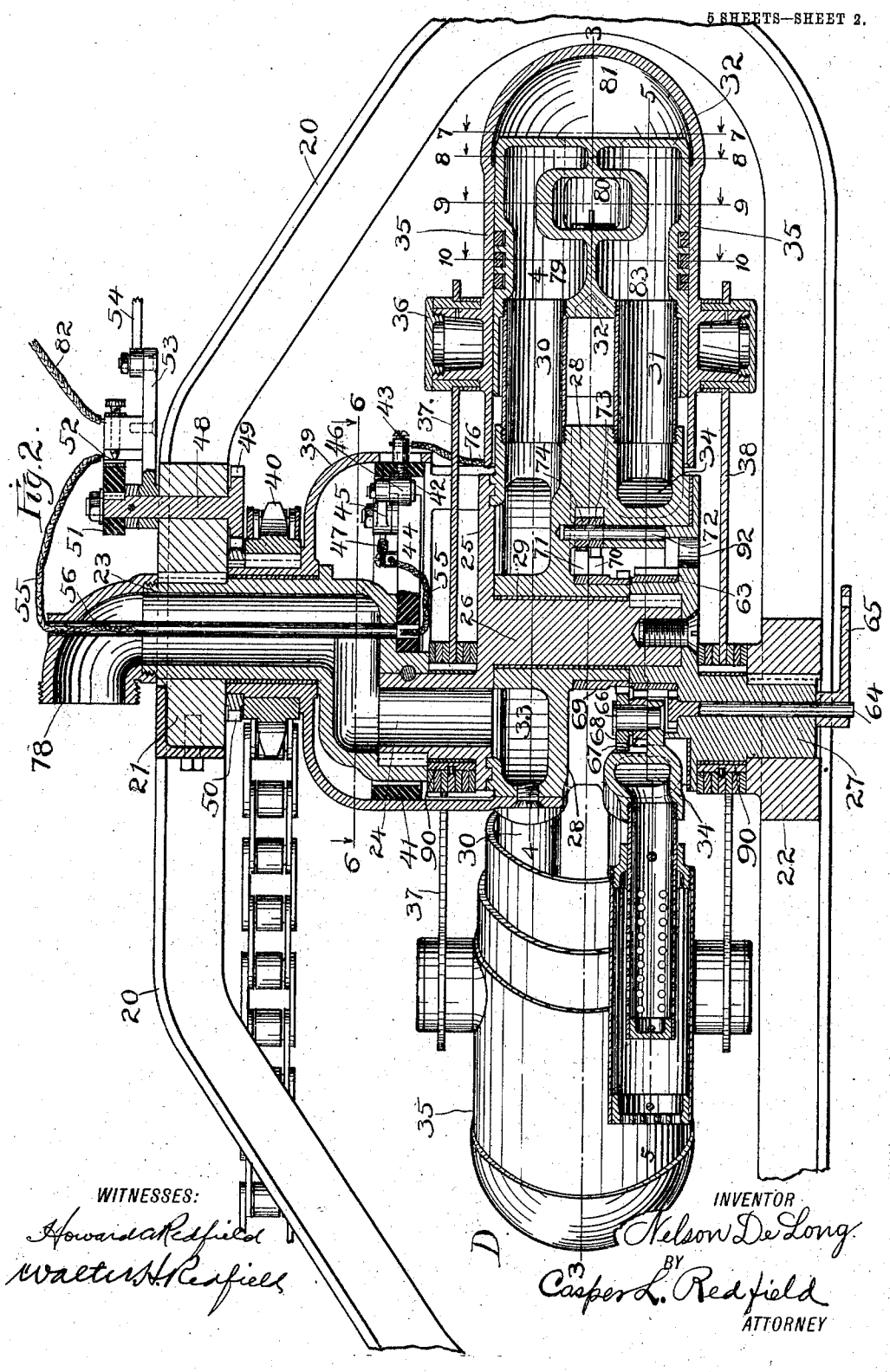
APPLICATION FILED JAN. 6, 1909.

967,735.

Patented Aug. 16, 1910.

5 SHEETS—SHEET 2.

Fig. 2.



WITNESSES:

Howard A. Redfield

Walter A. Redfield

INVENTOR

Nelson De Long.

BY

Casper L. Redfield

ATTORNEY

N. DE LONG.

GAS ENGINE.

APPLICATION FILED JAN. 6, 1909.

967,735.

Patented Aug. 16, 1910.

5 SHEETS—SHEET 3.

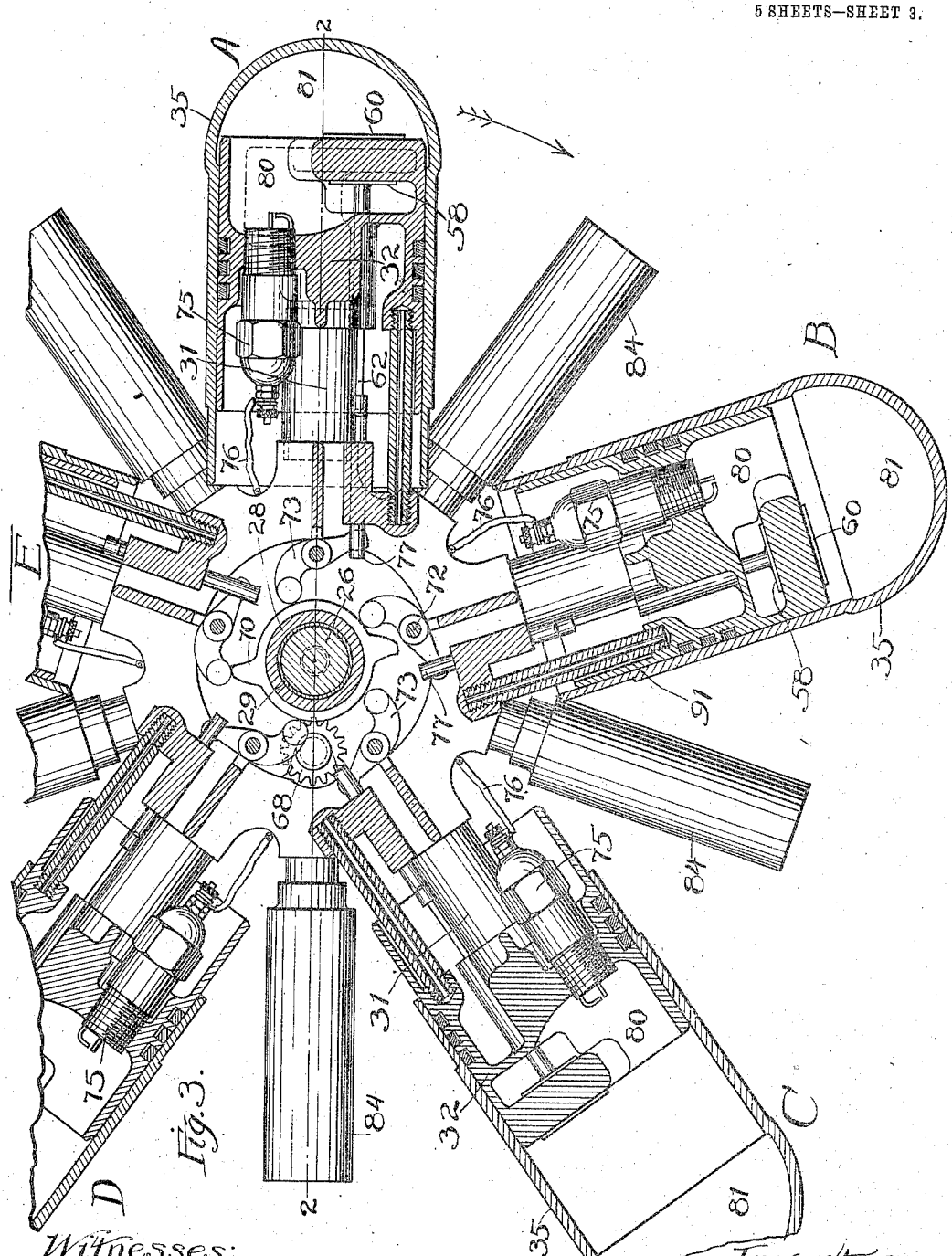


Fig. 3.

Witnesses:
Howard A. Redfield
Walter A. Redfield

Inventor
Nelson De Long
By Casper L. Redfield
Attorney.

N. DE LONG.

GAS ENGINE.

APPLICATION FILED JAN. 6, 1909.

967,735.

Patented Aug. 16, 1910.

5 SHEETS—SHEET 4.

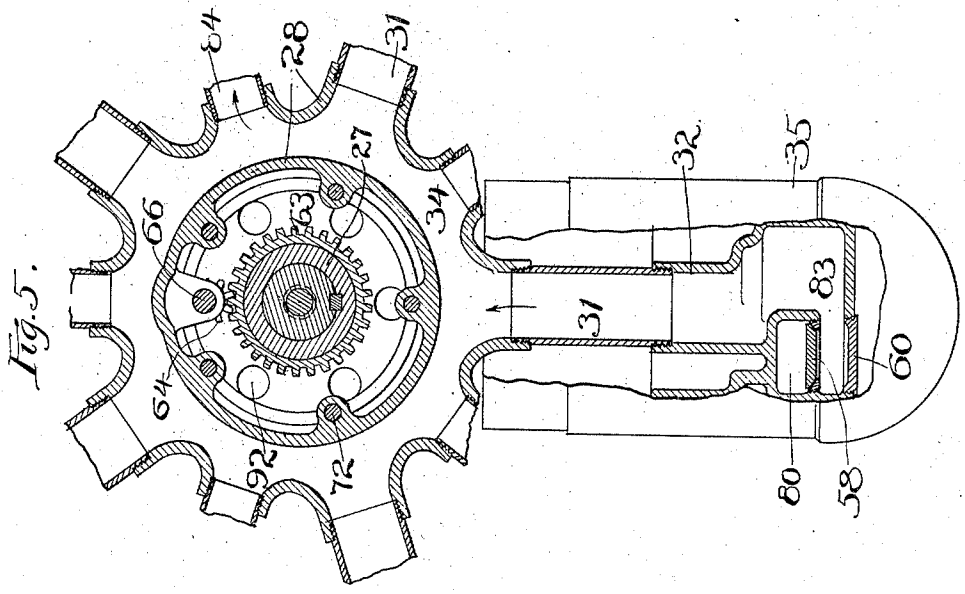


Fig. 5.

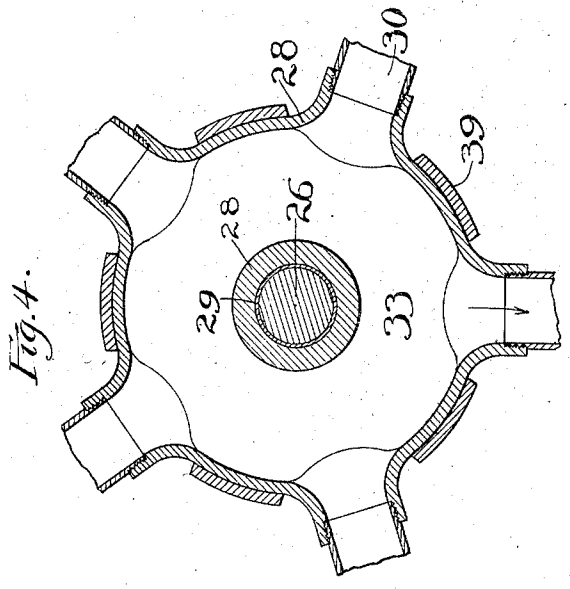


Fig. 4.

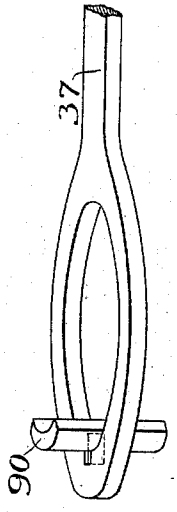


Fig. 12.

Witnesses:
Howard A. Redfield
Walter A. Redfield

Inventor:
Nelson De Long
By Casper L. Redfield
Attorney.

N. DE LONG.

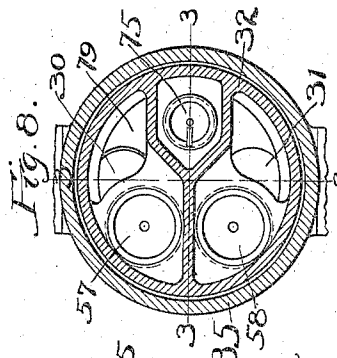
GAS ENGINE.

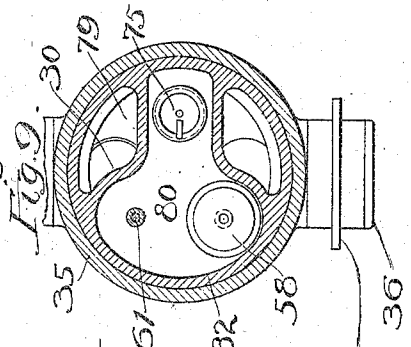
APPLICATION FILED JAN. 6, 1909.

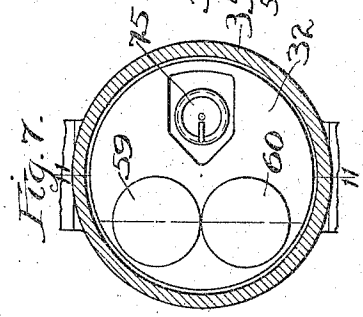
967,735.

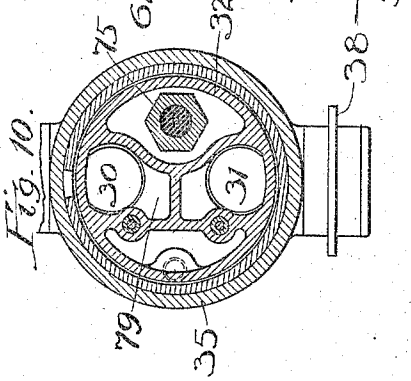
Patented Aug. 16, 1910.

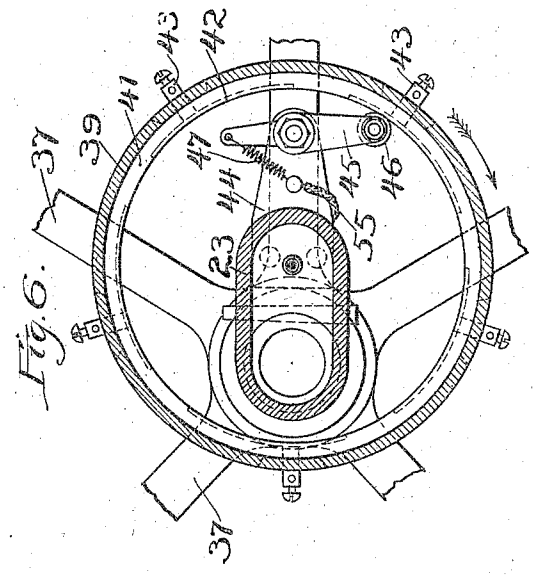
5 SHEETS—SHEET 5.

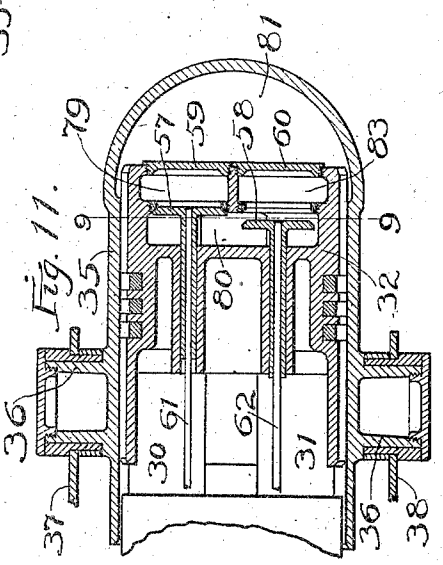












Witnesses:
Walter A. Redfield.
Howard A. Redfield.

Inventor
Nelson De Long
By Casper L. Redfield
Attorney.

UNITED STATES PATENT OFFICE.

NELSON DE LONG, OF CHICAGO, ILLINOIS.

GAS-ENGINE.

967,735. Specification of Letters Patent. Patented Aug. 16, 1910.

Application filed January 6, 1909. Serial No. 470,922.

To all whom it may concern:

Be it known that I, NELSON DE LONG, a citizen of the United States of America, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to gas engines, and has for its object improvements in engines of that kind.

In the accompanying drawings, Figure 1 is a plan; Fig. 2 is an enlarged section on line 2—2 of Fig. 1; Fig. 3 is a section on line 3—3 of Figs. 2 and 8; Fig. 4 is a section of a portion of the apparatus on line 4—4 of Fig. 2; Fig. 5 is a section on the broken line 5—5 of Fig. 2; Fig. 6 is a section on line 6—6 of Fig. 2; Figs. 7 to 10 are sections on correspondingly numbered lines in Fig. 2, the section for Fig. 9, also being shown on Fig. 11; Fig. 11 is a section on the broken line 11—11 of Fig. 7; Fig. 12 is a perspective of one end of one of the connecting rods.

In the said drawings, 20 is a frame providing an upper support at 21 and a lower support 22. Passing through and secured to the support 21 is a vertical tube 23 which serves both as an inlet pipe for mixed air and gas, and as a portion of the bearing on which the parts revolve. The lower portion of the tube 23 is bent at right angles and is rigidly secured to another piece 24 which forms a vertical continuation of the tube 23. The piece or part 24 is a tubular upward projection from a circular or disk-like piece 25, and from the lower face of 25 is a solid cylindrical projection 26, the axis of which is in line with the axis of the tube 23. Rigidly secured to the projection 26 is another cylindrical piece 27, the axis of which is in line with the tubular projection 24. The lower end of the piece or part 27 is held in the lower support 22. The various parts or pieces 23 to 27 are in effect one piece forming a stationary crank about which the parts revolve. The axis of parts 23 and 26 is the axis about which the pistons of the engine revolve, and the axis of the parts 24 and 27 is the axis for the cylinders and the connecting rods.

Mounted to rotate about the central stem 26 is a piston-supporting frame 28, a bushing 29 being inserted between 26 and 28 for anti-friction purposes. Radially projecting from the frame 28 are five pairs of tubes 30 and 31, and supported on the outer ends of each pair of such tubes is a piston 32. The upper tubes 30 communicate with an annular space 33 to which gas is admitted through the tubes 23 and 24. The lower radial tubes 31 communicate with a corresponding annular space 34 which leads to the exhaust.

Mounted to slide on each piston 32 is a cylinder 35, each cylinder 35 being provided with exterior trunnions 36 from which upper and lower connecting rods 37 and 38 extend to the parts 24 and 27.

Secured to the upper portion of the piston carrier or frame 28 is a casing 39 which incloses certain parts and which has a bearing upon the exterior surface of the inlet tube 23. On any suitable portion of this casing 39 is secured a sprocket wheel 40 or equivalent pulley for conveying power from the engine to any desired point.

At a convenient place on the interior surface of the casing 39 is a ring of insulating material 41 provided with five contact strips 42 having binding posts 43. Secured to the piece 23 is an arm 44 of insulating material, and on this arm is pivoted another arm 45 having a contact roller 46 adapted to make electrical connection successively with the contact strips 42 as the casing 39 and said strips move in the direction of the arrow in Fig. 6. A spring 47 acts to hold the roller in contact with said strips.

In the support 21 is a spindle 48 provided with a gear 49 which meshes with another gear 50 secured to the casing 39. On the upper end of the spindle 48 is a cam 51 which closes a contact making device 52 once during each revolution of the spindle 48. The contact making device 52 is supported on an arm 53 which is loosely pivoted on the spindle 48. A link 54 extends to any convenient fixed point and furnishes a means for adjusting the position of the arm 53 so that the contact device 52 will be closed earlier or later by the cam 51, as may be desired. The gearing 49—50 is so arranged that the contact device 52 will be closed each time that the contact roller 46 travels two-fifths of the circumference of the ring 41. Conducting wires extend to and from the contact closing device 52, as shown in Figs. 1 and 2. One branch 55 of this wire extends down through a small protecting tube 56 which passes through the tube 23 and the arm 44. The wire 55 then connects through a suitable binding post with the spring 47, as shown in

Figs. 2 and 6. The electrical connections are continued from binding posts 43 through wires 76 to the spark plugs 75, one such being secured in each piston. (Figs. 3, and 7 to 10.)

Each piston 32 has certain chambers and channels cored therein, which will be described in detail in describing the movements of the gas before and after ignition. Each piston also has valves 57 and 58 for controlling the movement of gas through these channels and chambers. Covers 59 and 60 in the outer faces of the pistons 32 permit access to these valves. The valves 57 and 58 are provided with stems 61 and 62 which extend toward the center of the engine, and apparatus like that shown at the center of Fig. 3 serves to control the valves through said stems.

On the upper cylindrical part of the piece 27 is an adjustable gear 63. (See Figs. 2 and 5.) This gear meshes with and is normally held stationary by a small pinion on the upper end of the spindle 64. A handle 65 on the spindle 64 serves as a means for adjusting the position of the non-rotating gear 63. Secured in the lower portion of the piston-holder 28 is a stud 66, on which are mounted gears 67 and 68 secured together, but of different diameters. The gear 67 meshes with the gear 63, and the gear 68 meshes with another gear 69 loosely mounted upon a portion of the piston carrier 28. The result of this arrangement is that gears 67 and 68 are planetary gears revolving about the stationary, but adjustable gear 63, and that the engagement between the gear 68 and gear 69 causes this last gear to revolve at a different speed from the speed of the piston-carrier. A portion of the sleeve on which gear 69 is formed also forms a ring having cams 70 as shown in Figs. 2 and 3. Secured to the ring having cams 70 is another ring having similar cams 71. (Fig. 2.)

At convenient points in the piston-carrier 28 are pins 72 on which are pivoted arms 73 and 74 operated upon by cams 70 and 71. Cams 71 and arms 74 form a set controlling the admission valves 57, and cams 70 and arms 73 form another set controlling the exhaust valves 58. As these two sets differ from each other only in the angular positions of the cams for controlling the times of opening and closing the admission and exhaust ports, the illustration of the exhaust set in Fig. 3 will serve as an illustration of both sets.

The valve stems 62 (Figs. 3 and 11) are connected to larger offset stems 77 which are provided with slots engaged by the free ends of the arms 73. As the cams 70 move relatively to the piston-carrier 28, by reason of the planetary gearing previously described; and as the arms 73 are supported on pins 72 in the carrier 28, the cams 70 will operate to intermittently open the valves 58. In a corresponding manner, the cams 71 will operate to intermittently open the valves 57. The valves are closed by the centrifugal action of the pistons and valves revolving about a center.

By inspection of Fig. 2 it will be seen that gas entering the elbow 78 has free access through 23 and 24 into the annular space 33, and from here through the tubes 30 into the chambers 79 of the pistons 32. The chamber 79 for any one piston can be best traced by comparing Figs. 2 and 8 to 11 with each other. For descriptive purposes the gas will be assumed as entering the piston shown at the right in Figs. 2 and 3, and that the pistons and cylinders are revolving in the direction of the arrow in Fig. 3. The successive positions of the pistons and cylinders are marked A, B, C, D and E. Gas entering the chamber 79 flows to that part of the chamber which is over the valve 57, as shown in Fig. 11, but does not pass through that valve at the time as it is held closed by centrifugal force. The valve 58 is also closed at this time. As the cylinder moves from the position A to the position B it also moves outward radially on its piston, being permitted to do so by its connecting rods 37 and 38, which are connected to the axis 24—27 while the piston is connected to the axis 26. It may be remarked that these connecting rods are intended to act only in tension, the force causing the outward movement of the cylinder being centrifugal force and the movement being restrained by the tension of the rods. This outward movement causes a vacuum or rarefication in the chamber 80, part of which extends under the valves 57 and 58, as will be seen by comparing Figs. 3 and 11. At the desired point in the movement of the cylinder from position B to position C, the valve 57 is opened and gas flows rapidly through this valve from chamber 79 to chamber 80 which is in free communication with the space 81 between the piston and the cylinder. The opening of this valve is caused by the movement of the cams 71 relatively to the arms 74, which cams and arms are, as previously described, similar to the cams 70 and arms 73. Also, as previously described, the exact time of opening the valve 57 is determined by adjusting the arm 65 (Fig. 2) so as to shift the fixed gear 63, which controls the cyclical gearing that in turn controls the movement of the cams 70 and 71 relatively to the arms 73 and 74. At about midway between positions C and D there is the maximum space over the piston and in the space 81. At this time the cam controlling the valve 57 releases it, and the said valve closes by centrifugal action. As the piston and cylinder continue to move through the positions D and E to position A, the cylinder is

drawn inward by the connecting rods 37 and 38, and the gas in space 81 is highly compressed. The contact closing device 52 (Fig. 2), and the contact device 46—42 (Fig. 6), have their movements so related to the movement of the cylinder, that a circuit is closed through the particular strip 42 which is associated with the spark plug 75 in the cylinder which is at position A, and has compressed gas therein as just described. This causes a current to flow from a suitable source of electricity through the wire 82 to the contact closing device 52, thence through wire 55 and associated parts to roller 46, thence to the strip 42 on which the roller 46 is at the time, thence through the wire 76 to the arcing points of the spark plug 75, and then to the frame of the engine, which represents ground. This ignites the compressed gas and causes an explosion, at the time when the cylinder is at or near the position A, which is its dead center.

As previously described, the exact time of closing the contact device 52 is adjustable by means of the pivoted lever 53 and its link 54. The length of the contact strips 42, engaged by the roller 46, is sufficient to permit of considerable adjustment in this respect. As the piston continues to revolve, passing through positions B and C, the exploded gas expands and furnishes power, through heavy tension on the connecting rods 37 and 38, to drive the engine forward. At about the time when the cylinder is midway between C and D, the cam 70 acts upon the lever 73 which is connected to the exhaust valve 58 in the piston for this cylinder. This permits the expanded gas to escape from chamber 80 to chamber 83, which chamber is in communication with the exhaust tube 31. The connections for this may be best seen by comparing Figs. 2, 5 and 11. As previously described, all tubes 31 communicate with the annular space 34. Extending radially from this annular space, and intermediate the cylinders, are a series of small exhaust mufflers which require no special description as to their details. The exhaust is, therefore, distributed to a plurality of mufflers, and the muffling effect is superior in consequence. The exhaust valve 58 is held open by the cam 70 while the cylinder is passing through the positions D and E, and is simultaneously drawn inward to expel the burned gas. At about the time the cylinder is again in position A the exhaust valve 58 is again closed, and the apparatus is in the position it was at the beginning of the above description. It will thus be seen that an explosion occurs in each cylinder once during each two revolutions, and as there are five cylinders, one or two are working at all times. Designating the cylinders by the letters heretofore used to represent the successive positions of one of them, after an explosion occurs in cylinder A the next explosion will be in cylinder D, the next in cylinder B, the next in cylinder E, the next in cylinder C, and then again in cylinder A. As thus described it will be seen that the pistons revolve about the axis of 26 and the cylinders revolve about the axis of 24—27. A diagram of the motion would be two overlapping circles drawn on to adjacent centers. The cylinders do not move through equal arcs in equal times, however, owing to the fact that the cylinders are constrained to move with respect to the pistons on the rigid radii of the pistons.

The cylinders are made as light as practicable, and have rounded ends to avoid sharp corners. The trunnions 36 are hollow and provided with caps as shown in Fig. 2. This furnishes a reservoir for lubricant for the bearings of the connecting rods 37 and 38. These connecting rods act in tension rather than in compression, and are little more than straps or links. As five of them connect to a single bearing forming the stationary crank, a special form is used to get a good surface on this bearing. This form is shown in Fig. 12. As these rods act only in tension there is only one part of the eye which is subjected to strain. At this point there is inserted in the eye, and secured thereto, a sector 90 of a hollow cylinder. The inside diameter of the cylinder from which these sectors are cut is the same as the outside diameter of the stationary crank bearings 24 and 27, and the outside diameter of the cylinder is the same as the inside diameter of the eye in the end of the rod 37. These various sectors are in the nature of a sectional bushing between the crank and the connecting rod. As the connecting rods do not all lie in the same plane they are connected to the different sectors at different positions in the axial lengths of the sectors. The top and bottom rods, of the series of five connected to one crank, are connected to the sectors near their ends, while intermediate rods are connected to their sectors at intermediate points. Fig. 12 illustrates one of the intermediate connecting rods. If there were no angularity to these connecting rods in the operation of the engine, each sector might be one-fifth of a circumference, and the five might form a complete bushing; but as these rods have angularity in their positions, and as the sectors are secured to the rods, the sectors are each somewhat less than one-fifth of a complete cylinder.

The pistons have been described as supported on the tubes 30 and 31. As shown in Figs. 2 and 5, these tubes are screwed into both the carrier 28 and the pistons 32, hence they serve not only as passageways for gas, but also as a means for adjusting said pistons radially with respect to the fixed axis about which they revolve. In addition to these supports there is in each piston a third

support 91 (Fig. 3) consisting of a post so located with reference to the strain under operating conditions as to best resist such strains. These posts or supports 91 are also adjustable in the same way as stated for tubes 30 and 31.

The cylinders are kept comparatively cool by their rapid revolution through free air. Except at the points where the exhaust tubes 31 enter the annular space 34, the lower interior portion of the carrier 28 is open and exposed to the free circulation of air, as will be seen by an inspection of the left central portion of Fig. 2.

To facilitate the circulation of air close to the bearing 26, about which the pistons revolve, the flange portion of the piece 27 has in it a series of holes 92. (Figs. 2 and 5.) As thus constructed the air circulates freely about the annular space 34 and the exhaust tubes 31 leading thereto. The rapid rotation of the cylinders causes a rapid circulation of air and prevents adjacent parts from becoming overheated.

What I claim is:

1. In a gas engine, the combination with a crank, and a plurality of cylinders revolving about said crank, of a corresponding plurality of connecting rods from said cylinders to the same bearing on said crank, each connecting rod being provided with a sector of a bushing, valves for admitting fresh gas into the cylinders, sparking devices for igniting the gas, and other valves for permitting the burned gas to escape.

2. In a gas engine, a piston carrier mounted to rotate about a fixed center, tubes attached to and extending radially from said carrier, pistons supported on said tubes, an inlet tube for admitting gas to said carrier from which such gas may flow through the radial tubes to said pistons, cylinders mounted to slide on said pistons, valves for permitting gas to flow from the pistons to the cylinders, means for igniting gas admitted to the cylinders so as to cause explosions and consequent reciprocations of the same, and connections from each cylinder to a second fixed center removed a small distance from the fixed center about which the carrier rotates.

3. In a gas engine, the combination with a series of pistons, revolving about a common fixed axis, a corresponding series of cylinders, and connecting rods from the cylinders to a second fixed axis whereby the cylinders revolve about a common fixed axis, of valves for controlling the admission and discharge of gas from the cylinders, sparking devices held in each piston, a contact closing device operated by the movement of the engine, and electrical connections from said sparking devices to said contact closing device.

4. In a gas engine, a piston carrier mounted to rotate about a fixed axis, said carrier providing an annular space for the admission of fresh gas and a second annular space for the outlet of burned gas, a series of radial tubes extending in pairs from the inlet and outlet spaces respectively, a chambered piston secured to each pair of tubes, a series of cylinders corresponding to the pistons and constrained to revolve about an axis adjacent to the axis of the carrier, valves for admitting fresh gas from the inlet tubes to the spaces between the pistons and the ends of their cylinders, sparking devices for igniting the gas so admitted, and other valves for permitting the burned gas to escape to the outlet tubes.

5. In a gas engine, a series of cylinders and a corresponding series of pistons arranged to revolve about adjacent fixed axes, a central body on which the pistons are carried and providing passageways for fresh and burned gas, a series of radial tubes extending in pairs from the said passageways, valves for admitting fresh gas to the spaces between pistons and the ends of their cylinders, and spark plugs for igniting the gas so admitted.

6. In a gas engine, a plurality of pistons mounted to revolve about a fixed center, a cylinder for each piston, connections from each cylinder to a fixed center other than about which the pistons revolve so that the cylinders move on their pistons, a piston carrier, adjustable tubes attached to and extending radially from said carrier to said piston, an inlet tube for admitting gas to said carrier, from which such gas may flow through the radial tubes to the pistons, valves for permitting gas to flow from the piston to the cylinders and sparking devices for igniting gas admitted to the cylinder so as to cause an explosion and a consequent reciprocation of the same.

7. In a gas engine, a series of pistons and a corresponding series of cylinders arranged to revolve about adjacent fixed axes, valves for controlling the admission and discharge of gas from said cylinders, planetary gearing located at and operating about one of said axes, cams operated by said gearing and serving to control the opening and closing of said valves, and a hand operated device for adjusting said gearing so as to vary the time of opening and closing said valves.

8. In a gas engine, a series of pistons and a corresponding series of cylinders arranged to revolve about adjacent fixed axes, a piston carrier providing passageways for gas to and from said cylinders, valves for controlling the flow of gas through said passageways, planetary gearing arranged to operate the valves of alternate cylinders in succession, and a hand operated device for adjusting said planetary gearing so as to vary the times of operating said valves.

9. In a gas engine, a series of pistons and a corresponding series of cylinders arranged to revolve about adjacent fixed axes, means for admitting fresh gas to said cylinders, a spark plug supported in each piston and having its sparking point in connection with the gas admitted to the associated cylinder, and means controlled by the movement of the engine for sending a current of electricity through said spark plug so as to ignite the gas in the cylinder.

10. In a gas engine, a series of pistons and a corresponding series of cylinders, valves for admitting gas to different cylinders in succession, a spark plug supported in each piston, a contact closing device operated by the movement of the engine, and electrical connections from said contact closing device to all of said spark plugs.

11. In a gas engine, a series of pistons and a corresponding series of cylinders, valves for admitting gas to different cylinders in succession, a spark plug supported in each piston, a contact closing device operated by the movement of the engine, interrupted electrical connections from the contact closing device to each spark plug, and a distributing contact device arranged to complete the electrical connections from said contact closing device to different spark plugs in succession.

12. In a gas engine, a series of pistons and cylinders, a corresponding series of contact strips located in a circle, a traveling contact device arranged to engage said strips in succession, a sparking device associated with each piston and its cylinder, electrical connections from each sparking device to a different contact strip, a second contact device arranged to close electrical connections to said traveling devices at times when said traveling device is in electrical connection with one of said strips, and an adjustable device for varying the time at which said second contact device shall close electrical connections.

13. In a gas engine, a fixed crank providing an inlet for gas, a piston carrier mounted to rotate about one axis of said crank and having a chamber communicating with the inlet opening in said crank, a series of pistons secured to said carrier, the carrier and the pistons being provided with passageways for gas from the chamber in the carrier to the pistons, a cylinder for each piston, valves for admitting gas from the pistons to the cylinders at predetermined points in their movements, means for igniting the gas so admitted at predetermined times, and connecting rods extending from pivots on all of the cylinders to the other axis of the crank.

14. In a gas engine, the combination with a crank, and a plurality of reciprocating members, of a corresponding plurality of connecting rods from said members to the same bearing on said crank, each connecting rod being provided with a sector of a bushing, substantially as described.

15. In a gas engine, the combination with a crank, and a plurality of cylinders revolving about said crank, of a corresponding plurality of connecting rods from said cylinders to the same bearing on said crank, the eyes in said connecting rods being of greater diameter and less length than the bearing of the crank to which they extend, and plurality of sectors of a bushing located between the bearing and the eyes, one sector being connected to the eye of each connecting rod.

16. In a gas engine, a series of pistons extending radially from and revolving about a fixed axis, a cylinder for each piston, means for admitting gas to the cylinders and igniting the same so as to cause revolutions of the pistons, a framework providing an exhaust chamber into which burned gases are discharged from said cylinders, and a series of mufflers communicating with said exhaust chamber and extending radially from the fixed axis at points between said pistons.

Signed at Chicago, Ill., this 4th day of Jan. 1909.

NELSON DE LONG.

Witnesses:
WALTER H. REDFIELD,
CARRIE E. JORDAN.