No. 885,921. PATENTED APR. 28, 1908.

C. GRISWOLD & S. G. AVERELL.

GAS ENGINE.

APPLICATION FILED DEC. 21, 1906.

4 SHEETS—SHEET 1.

Fig. 1.

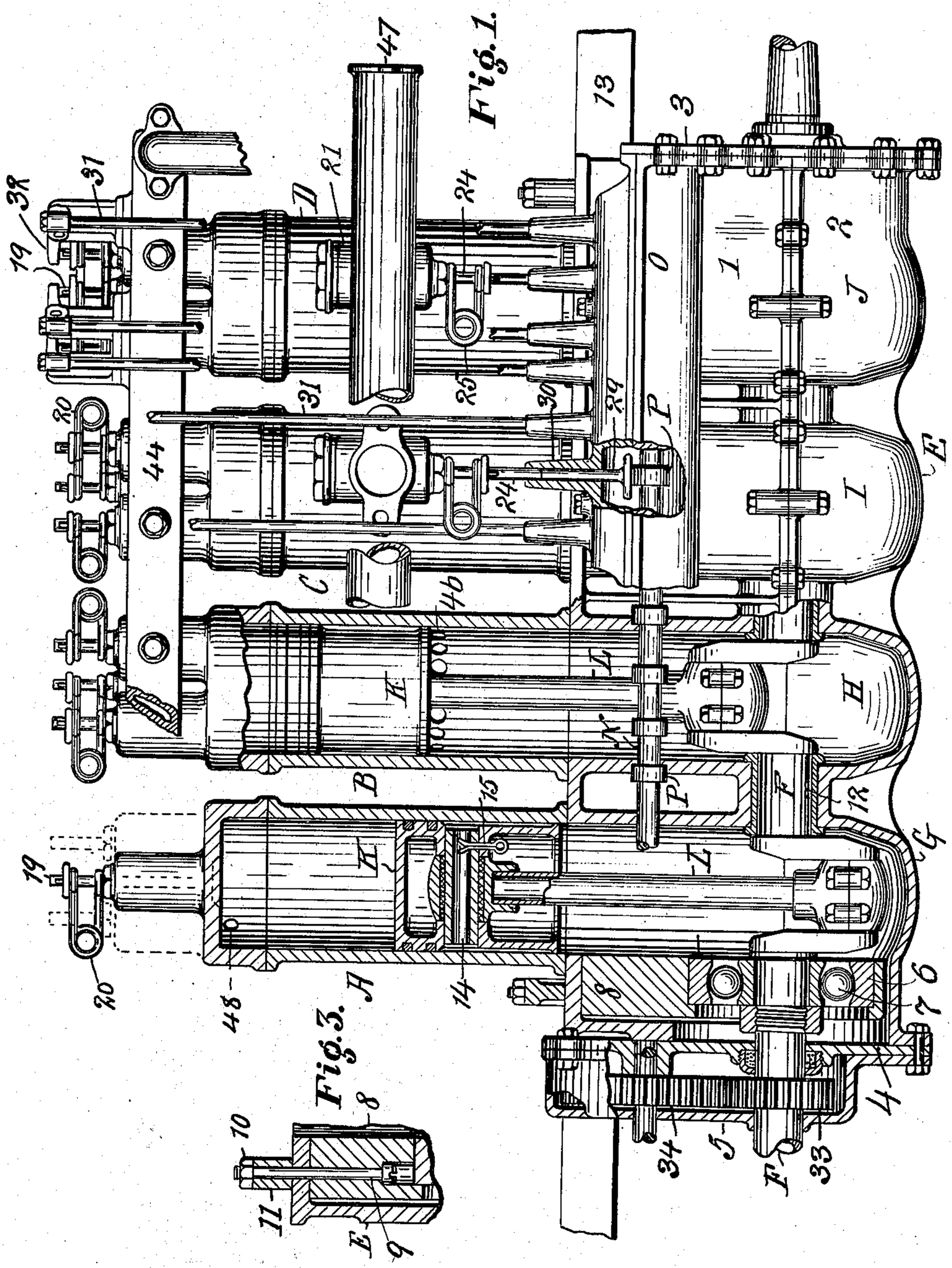
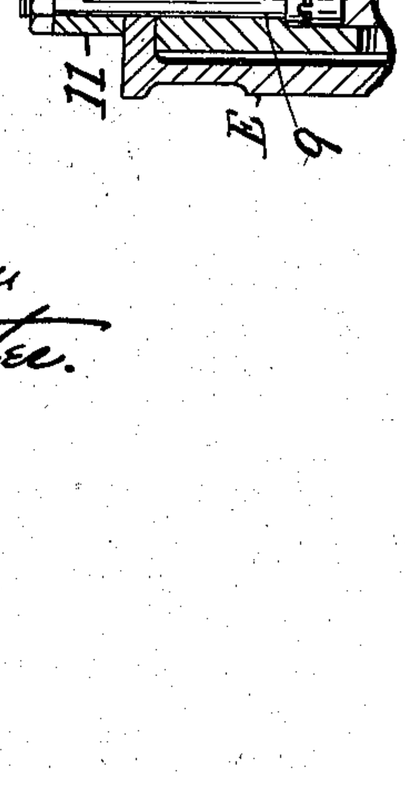


Fig. 3.



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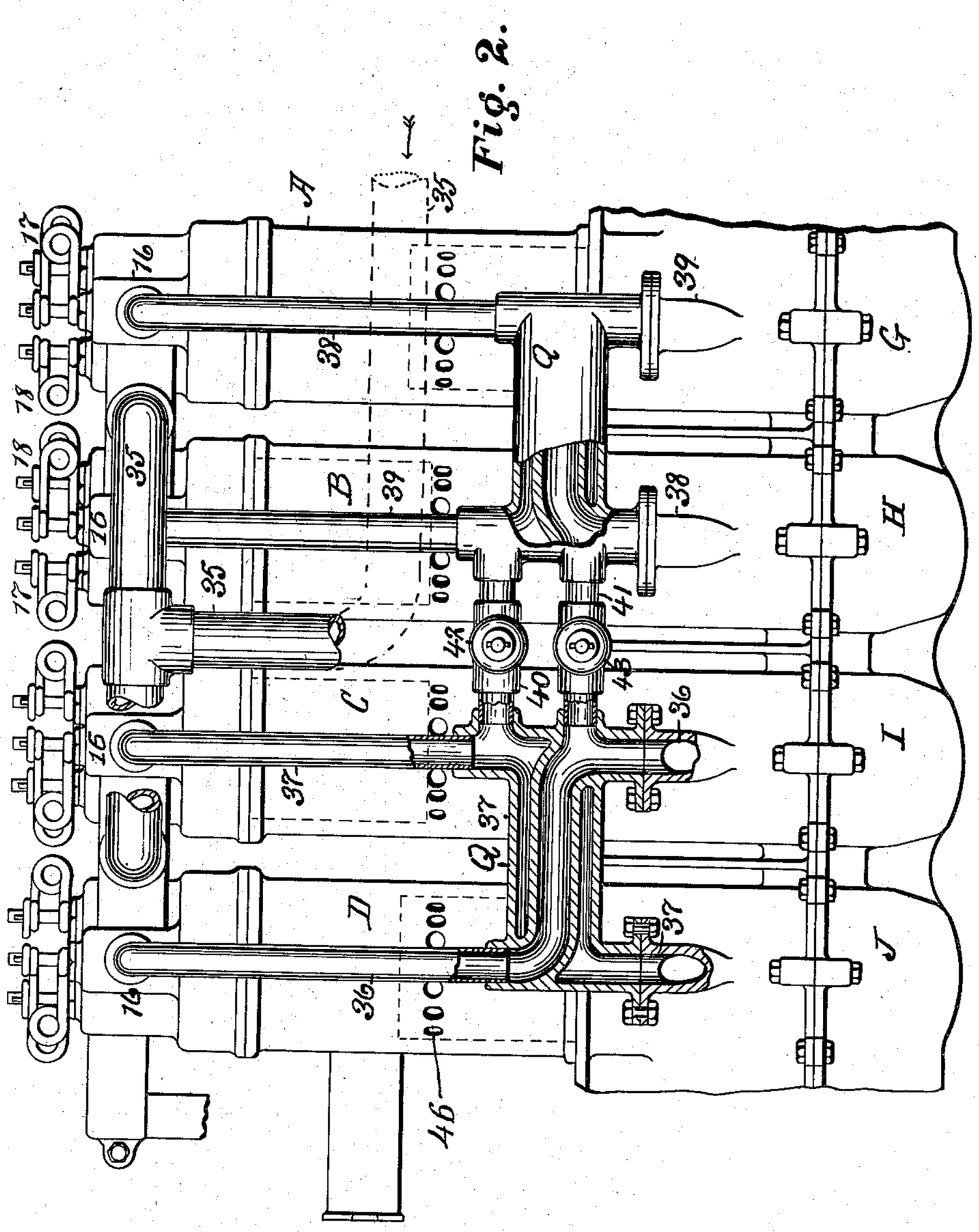
4 SHEETS—SHEET 2.

Fig. 2.



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4 SHEETS—SHEET 3.

Fig. 9.

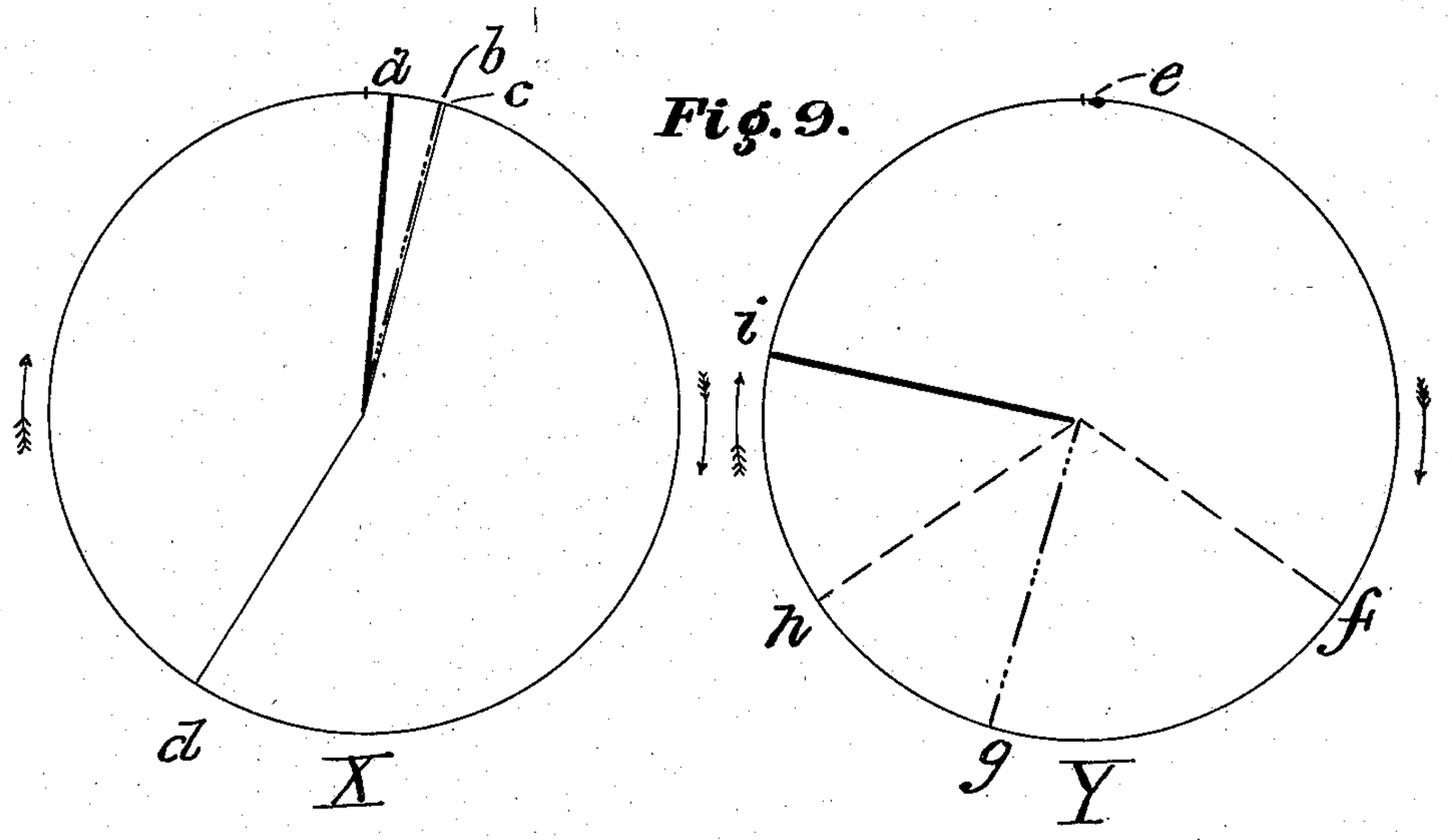
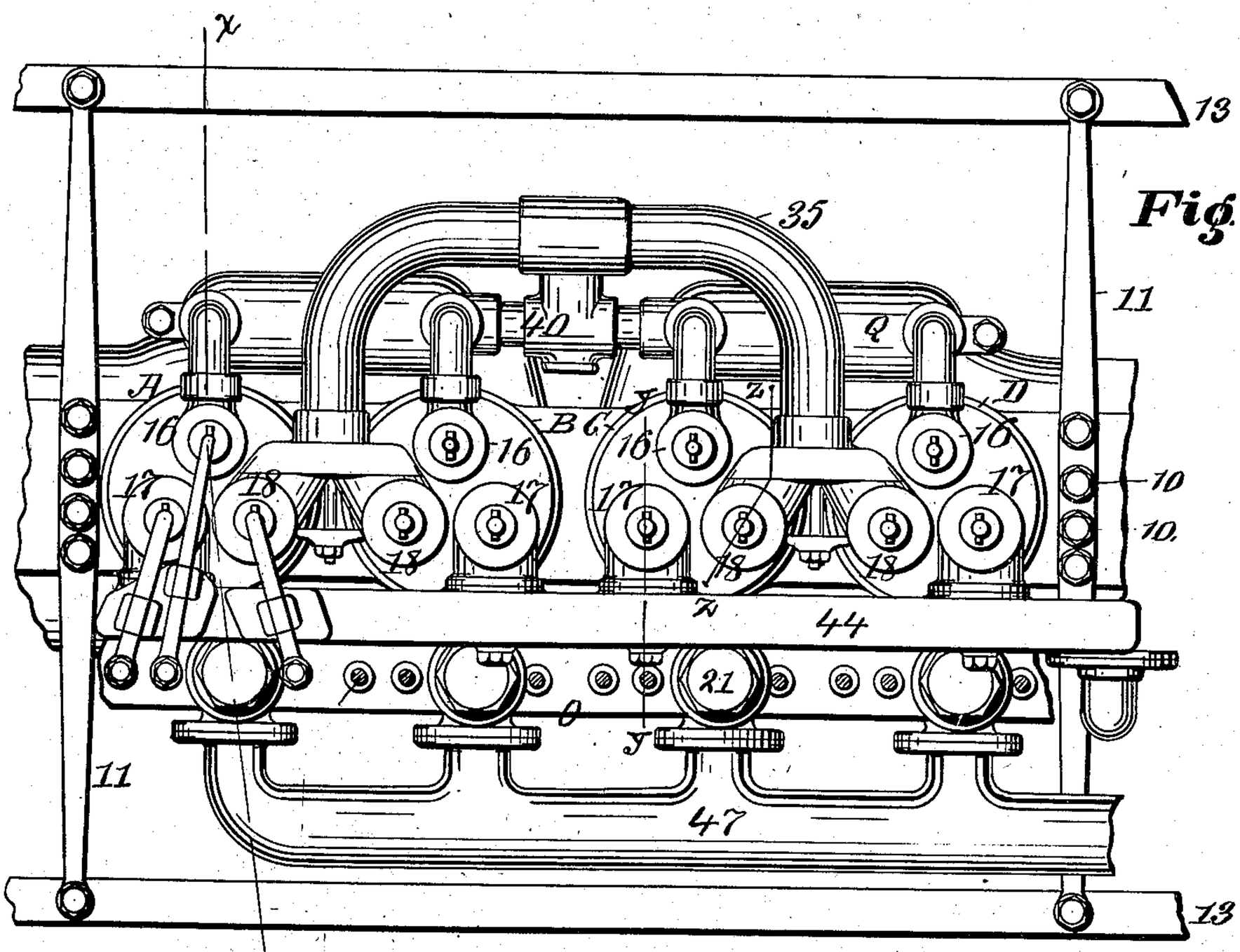


Fig. 4.



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4 SHEETS—SHEET 4.

Fig. 5.

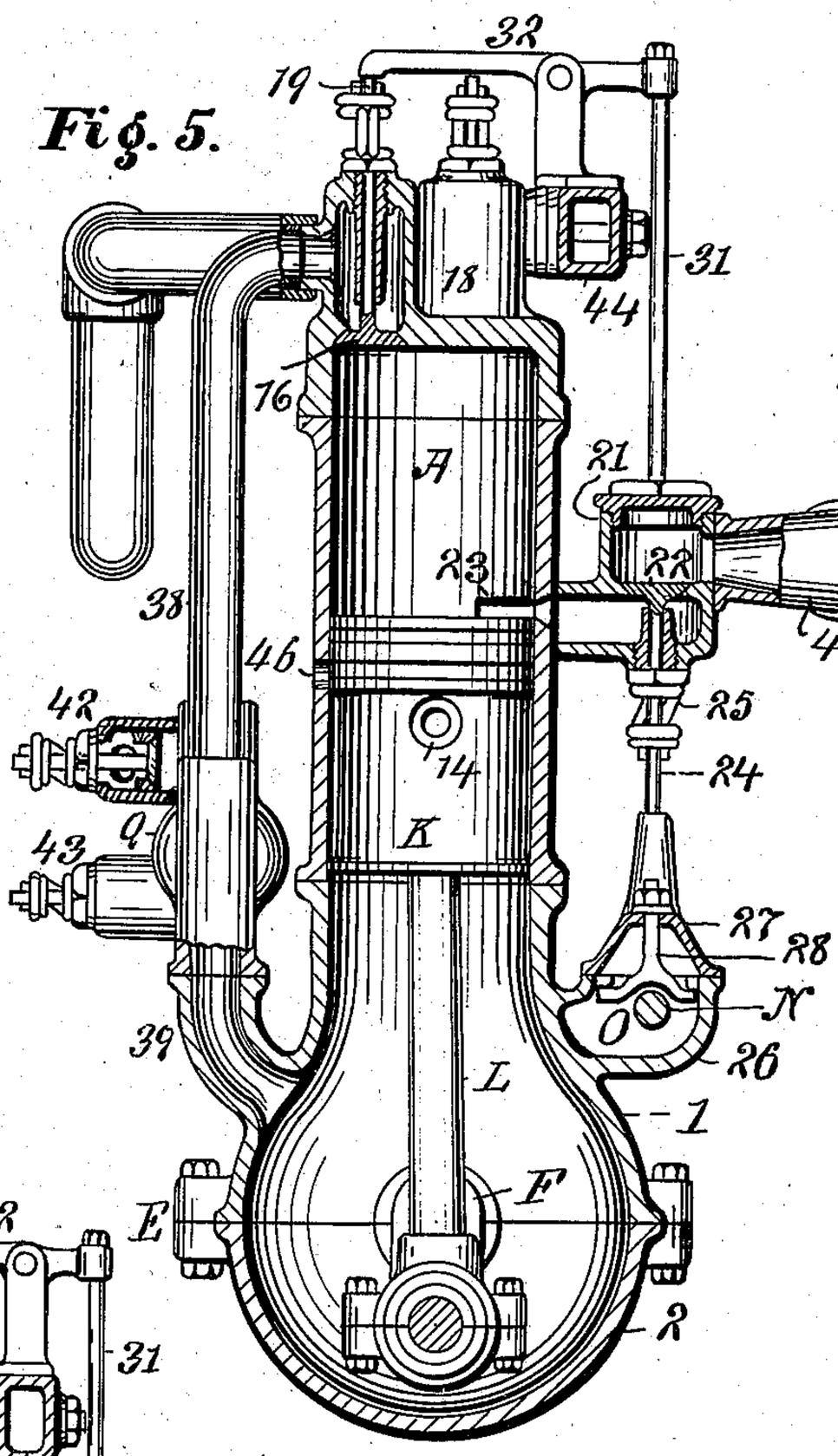
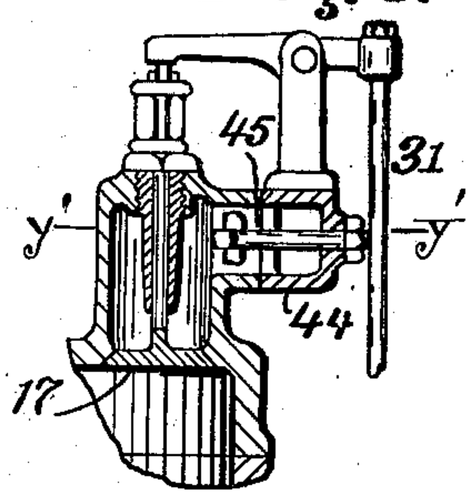


Fig. 6.



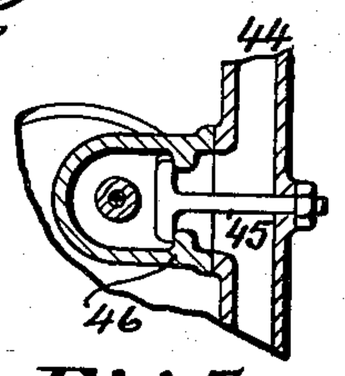


Fig. 7.

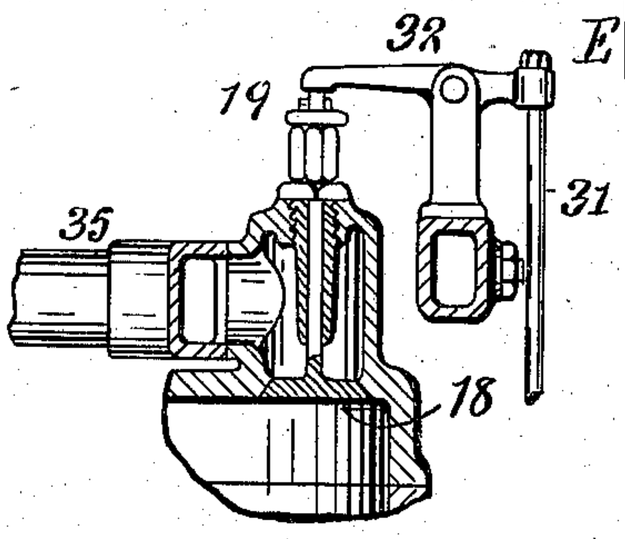


Fig. 8.

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UNITED STATES PATENT OFFICE.

CHESTER GRISWOLD AND SYLVESTER G. AVERELL, OF NEW YORK, N. Y.

GAS-ENGINE.

No. 885,921. Specification of Letters Patent. Patented April 28, 1908.

Application filed December 21, 1906. Serial No. 348,863.

To all whom it may concern:

Be it known that we, CHESTER GRISWOLD and SYLVESTER G. AVERELL, citizens of the United States, residing at New York, in the county of New York and State of New York, have invented a certain new and useful Improvement in Gas-Engines, of which the following is a specification.

The invention relates to gas engines of the type in which working strokes of the piston alternate with gas suction strokes, and more particularly to those in which air for purging the cylinder free of combustion products is compressed by the working piston.

The invention consists in the construction of the engine whereby the purging is caused to take place during a rearward stroke of the piston and preferably at or about the middle of said stroke; whereby an auxiliary exhaust is provided to reduce heating in the cylinder, increase effective exhaust area and achieve other advantages hereinafter set forth; whereby, in the air compression chamber, an auxiliary air inlet is provided; whereby, in a multiple engine, the cylinder of each engine of a pair is purged by air compressed by the other engine and whereby in a multiple engine, such as herein specifically illustrated, each engine cylinder is purged by air compressed in two independent chambers by two of the associated engines.

In the accompanying drawings—Figure 1 is a front elevation of a four cylinder four-cycle engine embodying our invention, certain parts being shown broken away and in section. Fig. 2 is a rear elevation showing more particularly the air purge connections. Fig. 3 is a detail section showing the mode of connecting the ball bearing block 8 to the base E. Fig. 4 is a top view of the engine. Fig. 5 is a vertical transverse section on the line $x\ x$ of Fig. 4. Fig. 6 is a vertical section on the line $y\ y$ of Fig. 4. Fig. 7 is a horizontal section on the line $y'\ y'$ of Fig. 6. Fig. 8 is a vertical section on the line $z\ z$ of Fig. 4. Fig. 9 is a diagram showing the operations of the valves for a complete cycle.

Similar numbers and letters of reference indicate like parts.

The engine is of the four cycle type and has four vertical cylinders A, B, C, D, secured in any suitable way upon the hollow base E. Said base is divided horizontally in two parts, the upper portion 1 being flanged and bolted to the lower portion 2. At one end of said base is a head 3 bolted in place. At the other end is a head 4 similarly bolted in place and carrying a gear case 5, in which are located the gears hereafter to be described. Through the base E passes the engine crank shaft F. Near each end of the shaft F is a ball bearing of known construction, comprising an inner rim rigidly secured on said shaft between a collar and a nut, an outer rim 6 and intermediate balls 7. The outer rim is held in a supporting block 8, which is secured to the upper wall of the base E by bolts 9, Fig. 3, said bolts passing through said wall and being secured by nuts 10 to the cross supporting bars 11. The shaft F also passes through stuffing boxes in the heads.

The base E is divided into four chambers G, H, I, J, which respectively receive the cranks on shaft F. Between the chambers are bearings for shaft F provided with horizontally divided bushings 12, so that there is no communication between the crank chambers, except as hereinafter explained. The cranks belonging to cylinders B, C, are set 180° from the cranks belonging to cylinders A, D.

The cross bars 11 may rest upon the longitudinal members 13 of a supporting frame, such as the frame of an automobile, and, in this way, the entire machine is supported. It results from this construction that the lower part of the base E can be removed to permit of cleansing or for any other desired purpose, without disturbing the rest of the machine.

In each cylinder A, B, C, D, is a piston K, each piston being connected by its rod L, to one of the cranks on shaft F. The piston rod L is connected to its piston by the usual wrist pin 14 into which enters a cotter pin 15 to prevent longitudinal motion thereof.

On the upper end of each cylinder is a cup-shaped head in which are arranged three puppet valves; 16, Fig. 5; 17, Fig. 6: and 18, Fig. 8; all opening inwardly and disposed in housings preferably cast integral with said head. The valves 16 admit purging air to the several cylinders. The valves 17 are the main exhaust valves. The valves 18 are the gas intake valves. Each valve stem 19 extends upwardly through the valve housing and is provided with a spring 20, which normally keeps the valve closed.

On the side of each cylinder is secured a cylindrical casing 21 containing a puppet valve 22 (which is an auxiliary exhaust valve) and communicating with the cylinder

interior by a port 23. The valve stem 24 extends downwardly and is provided with a spring 25 which normally holds the valve down upon its seat.

In order to operate the several valves there is provided a shaft N journaled in suitable bearings in a chamber O, the lower part 26 of which is preferably cast integral with the upper part 1 of base E (Fig 5) and which does not communicate with the chambers G, H, I, J, in said base. The upper part 27 of said chamber is secured to the lower part by T bolts 28, engaging with lugs and set up by nuts as shown. On said shaft N are cams P upon which bear the enlarged lower ends of rods 29, which rods extend upwardly into guides 30, and terminate therein. (Fig. 1).

The stems 24 of valves 22 bear on the upper ends of certain of said rods 29, so that by the rotation of shaft N and the action of the cams P, said valves are operated. Valves 16, 17 and 18 are in like manner operated from cams P through other rods 29, similarly arranged and bearing on said cams, and rods 31 which bear on the upper ends of said rods 29. The said rods 31 (Fig. 5) at their upper extremities are connected to the short arms of pivoted levers 32, the long arms of which extend over and act upon the upwardly projecting valve stems 19. As the amount of opening of the valves is small, a loose joint at the points of connection between each rod 31 and its associated lever 32 will give sufficient play to the parts.

On the shaft F is a toothed gear 33 and on the shaft N is a toothed gear 34 engaging with gear 33. Shaft N is, therefore, rotated by shaft F, and the relation of the gears is such that said shaft N makes one revolution to two revolutions of shaft F. As already described through the cams P vertical movement is imparted to rods 29 and so to the valve rods.

The gas, air and exhaust conduits are disposed as follows: Referring to Figs. 2 and 4, the explosive mixture from the source of supply proceeds by the pipe 35 and its branches, to the several gas valves 18.

Purging air which is compressed by the descent of pistons K in the several chambers G, H, I, J, reaches the cylinders as follows: With respect to cylinders C and D, (see Fig. 2), its course is from chamber I by conduit 36 to air valve 16 of cylinder D. From chamber J by conduit 37 which over a part of its length may inclose conduit 36, to air valve 16 of cylinder C. The conduits 36 and 37 may, where one incloses the other, be formed in a single casting as shown at Q. With respect to cylinders A and B: the course of the purging is from chamber H by conduit 38 to air valve 16 of cylinder A. From chamber G by conduit 39 which over a part of its length incloses conduit 38, to air valve 16 of cylinder B.

The air passages of the cylinders A, B, C, D, are also interconnected in the following manner: Conduit 37 is connected by pipe 40 to conduit 39. Conduit 36 is connected by pipe 41 to conduit 38. In pipes 40 and 41 are air check valves 42, 43, which open inwardly to permit atmospheric air to enter said pipes.

The chambers of the several main exhaust valves 17 are all connected to the header pipe 44, which leads the exhaust to atmosphere, or as desired. The mode of connection is shown in Figs. 6 and 7. A T-bolt 45 enters the valve chamber and engages with lugs 46 therein. Its shank passes through the header wall and is set up by a nut on the outside.

The chambers 21 of the auxiliary exhaust valves 22 are all connected to the header pipe 47 which leads to atmosphere or as desired. The spark plugs (48, Fig. 1) in the several cylinders are disposed in the upper parts thereof and may be timed so that ignition is produced in said cylinders in the order A, C, B, D. The cranks are set so that the pistons in cylinders C, B, ascend and descend together, and the pistons in cylinders A, D, ascend and descend together.

The complete cycle for each engine of the four connected to shaft F is shown in the diagram Fig. 9, which illustrates the operations of the valves for two complete revolutions of the crank of said engine. Referring first to the circle X on the left of Fig. 9. The piston is at the end of its upward stroke and is beginning to descend and thus to take in gas. When the crank has moved in the direction of the arrow slightly beyond its center, say 5 degrees, the air valve 16 closes. This is indicated by the black line *a*. After the crank has moved, say 15 degrees, the main exhaust valve 17 closes and the intake inlet 18 opens at the same time. This is indicated by the thin full line *c* and the dot and dash line *b*, placed close together. The piston completes its downward stroke and begins to rise. When the crank has passed about 30 degrees over the center the intake valve 18 closes. This is indicated by the thin full line *d*. The piston continues to rise compressing the explosive mixture, completes its upward stroke and begins its down stroke. Continue on circle Y. As the crank about passes its center the igniter acts and explosion occurs. This is indicated by the point *e*. The piston now descends on its working stroke until just before it uncovers the auxiliary exhaust port 23, the crank having passed over about 125 degrees. The auxiliary exhaust valve 22 opens. This is indicated by dash line *f*. The piston completes its working stroke and begins to rise. When the crank has passed the center by about 15 degrees, the main exhaust valve 17 opens. This is indicated by the dot and dash line *g*.

When the rising crank has passed over about 55 degrees and the piston has covered the auxiliary exhaust port 23, the auxiliary exhaust valve closes. This is indicated by the dash line *h*. The piston continues to rise, and when the crank has reached a point about 100 degrees from its lowest position, the air valve 16 opens. This is indicated by the line *i*. The piston then completes its upward stroke and the cycle ends.

Particular attention is called to the following facts: Referring to Fig. 2, and considering only cylinders C and D, and assuming for the moment, that the connecting pipes 40 and 41 were closed, the descent of the piston in cylinder C would obviously compress air in chamber I and in the conduit 36, and that air would be retained in that chamber and conduit as long as the valve 16 on cylinder D remained shut. Similarly, the descent of the piston in cylinder D would compress air in chamber J and in conduit 37, and that pressure would remain stored so long as the valve 16 remained shut; but the air valves 16 are opened once in each cycle, or, in other words, not on every stroke but on every alternate stroke of the pistons. The result, therefore, is that the piston in cylinder C compresses air in chamber I, which air is stored, and is finally delivered for purging purposes into cylinder D: and in like manner the piston in cylinder D compresses air in chamber J, which is stored, and afterwards delivered for purging purposes into cylinder C. In other words, each engine of the two under consideration, compresses and supplies purging air, not for its own cylinder, but for the cylinder of the other engine of the pair, and that is equally true of the second pair of engines having the cylinders A and B, with respect to one another. But in the whole machine here shown, the two pairs of cylinders, A B in one pair and C D in the other are connected in the manner described, by the pipes 40, 41. The consequence is, that as the pistons in cylinders B and C go down, they both act to compress air in their own chambers H and I, which are respectively connected to the air valves of cylinders A and D. Now if both of these air valves on cylinders A and D opened at the same time, it is obvious, that the total amount of air compressed would be divided between the two cylinders; but these two air valves do not open at the same time, but alternately; the consequence is, that all of the air compressed in the chambers H and I is turned either into the cylinder D or the cylinder A, as the case may be. Hence, on every forward stroke of the pistons in C and B the air compressed is utilized either, as stated, in the cylinder A or the cylinder D, and the actual amount of purging air which goes into either cylinder A or cylinder D is obviously twice the amount which would be driven into it by the action of its companion cylinder C or B acting alone. The net result, therefore, is this: Not one engine out of the four combined in this machine stores and compresses air for itself only; two engines out of the four are always compressing and storing air for one of the other two engines. By reason of the first fact we avoid all the difficulties and disadvantages incident to those forms of gas engines which compress their own purging air. By reason of the second fact, we supply twice the normal amount of purging air in a given time to each engine, thus effecting a far more efficient purge than is otherwise possible.

The purging air is normally drawn in through the check valves 42 and 43, in pipes 40 and 41. If, for any cause, during the rise of the pistons the pressure beneath them should fall below that of the atmosphere, we relieve this condition by providing in the walls of the cylinders, ports 46, opening directly into the outer air, and these ports, as Fig. 2 shows, are uncovered just as the piston reaches the end of its rearward stroke, thus admitting an additional free supply of air from the outside, and insuring that the air is afterwards compressed from atmospheric pressure on the subsequent descent of the piston.

The timing of the purge valve is preferably such that the air is admitted, not as is commonly the case, when the piston is at the beginning of its exhaust stroke, but during said stroke and preferably near the middle thereof (see *i*, circle Y, Fig. 9). In this way, the purge acts upon a very much smaller body of combustion products.

The auxiliary exhaust 23 has numerous advantages. It reduces the heat of the cylinder, makes it needless to muffle the main exhaust, enlarges the effective exhaust area, insures better self cleansing of the cylinder, reduces the heating of the main exhaust valve and so increases its lifetime, and by reason of its special construction tends to be opened by the outflow of burned gas and to be closed by the suction so that weakening of the spring is immaterial.

We claim:—

1. The combination of two gas engine cylinders and, associated with each cylinder, a piston and a compressed air chamber in the cylinder base receiving said piston, a crank shaft common to both pistons passing through said compressed air chambers and having its crank in one chamber set 180° distant from the crank in the other chamber, an air inlet valve in each cylinder head, ducts connecting the said air chamber associated with each cylinder with the air inlet valve of the other cylinder and means actuated by said crank shaft for operating said air inlet valves.

2. The combination of four gas engine cylinders and, associated with each cylinder, a piston and a chamber wherein air is compressed by said piston, connecting ducts between said chambers and said cylinders, valves in said ducts and means for operating said valves: the aforesaid parts being constructed and operating so that the compressed air in two of the said air chambers associated with said cylinders is intermittently admitted to one of the cylinders associated with the remaining chambers to purge combustion products therefrom.

3. The combination of four gas engine cylinders and, associated with each cylinder, a piston and a compressed air chamber in the cylinder base receiving said piston, a crank shaft common to all of said pistons passing through said air chambers and having two cranks in two chambers set alike and at 180° distance from the remaining cranks respectively in the other two chambers, an air inlet valve in each cylinder head, ducts connecting the air chamber associated with each cylinder with the air inlet valves of two of the other cylinders, and means actuated by said crank shaft for operating said valves.

4. The combination with four gas engine cylinders, a piston in each, independent air chambers in the crank cases of said cylinders, a crank shaft common to said pistons passing through said chambers, and piston rods extending from the pistons to the cranks, of means for causing simultaneous compression in two crank cases and means for transferring the entire charge thus compressed to a third cylinder for purging.

5. The combination of four engine cylinders, a piston in each, piston rods, independent air chambers in the crank cases of said cylinders, a crank shaft to which the piston rods are connected, the aforesaid parts being constructed and operating to compress air simultaneously in two crank cases, and means for transferring the entire charge thus compressed to a third cylinder for purging the said parts being also constructed and operating to subsequently compress air in two more crank cases and then discharging the air thus compressed into another cylinder for purging.

In testimony whereof we have affixed our signatures in presence of two witnesses.

CHESTER GRISWOLD.
SYLVESTER G. AVERELL.

Witnesses:
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H. M. LLOYD.