

F. O. KILGORE.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED MAY 28, 1912.

1,056,690.

Patented Mar. 18, 1913.

4 SHEETS—SHEET 1.

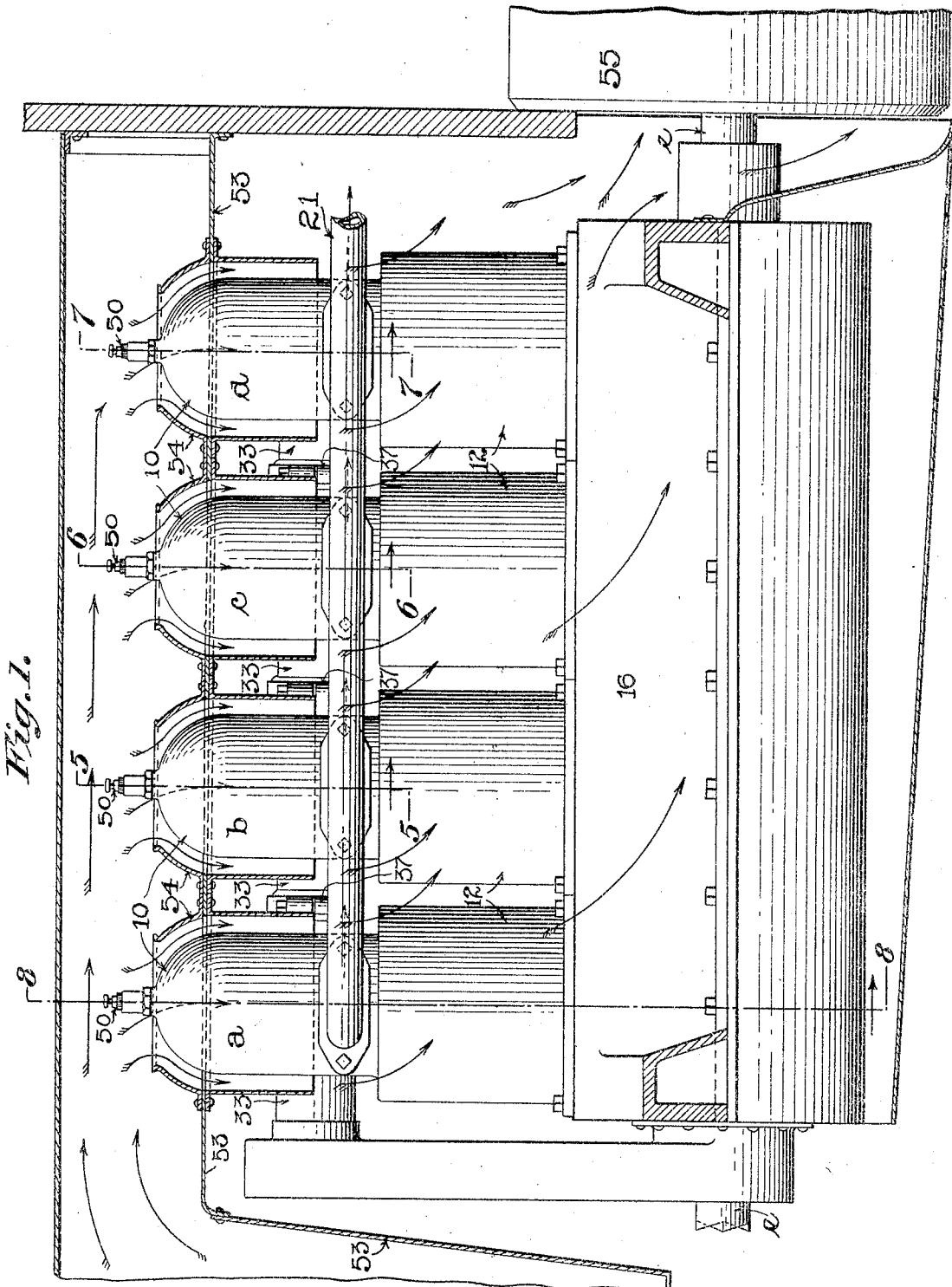


Fig. 1.

Witnesses:
W. G. Prosser,
J. Murphy.

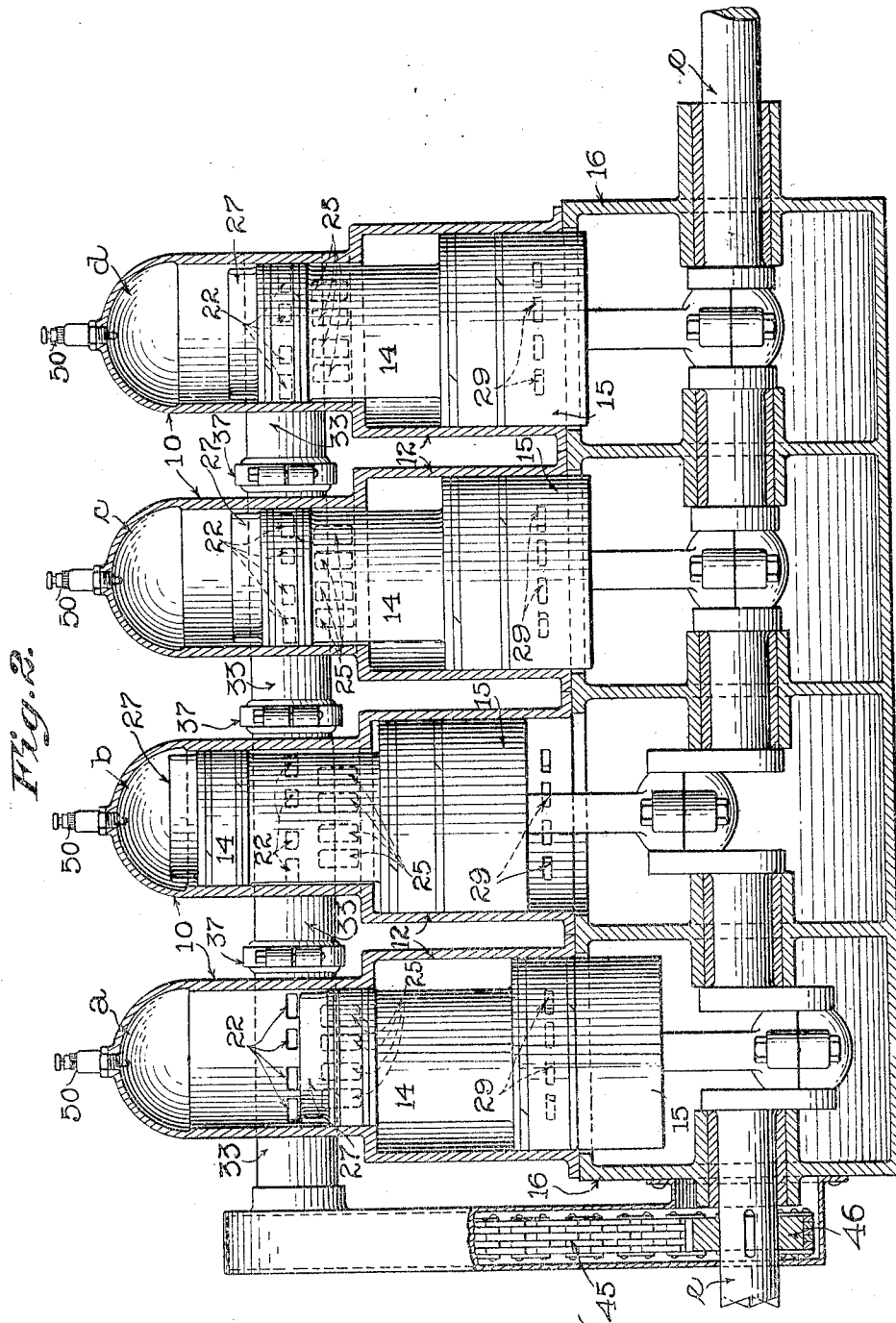
Inventor,
Frederick O. Kilgore
by Jas. H. Churchill
Attorney.

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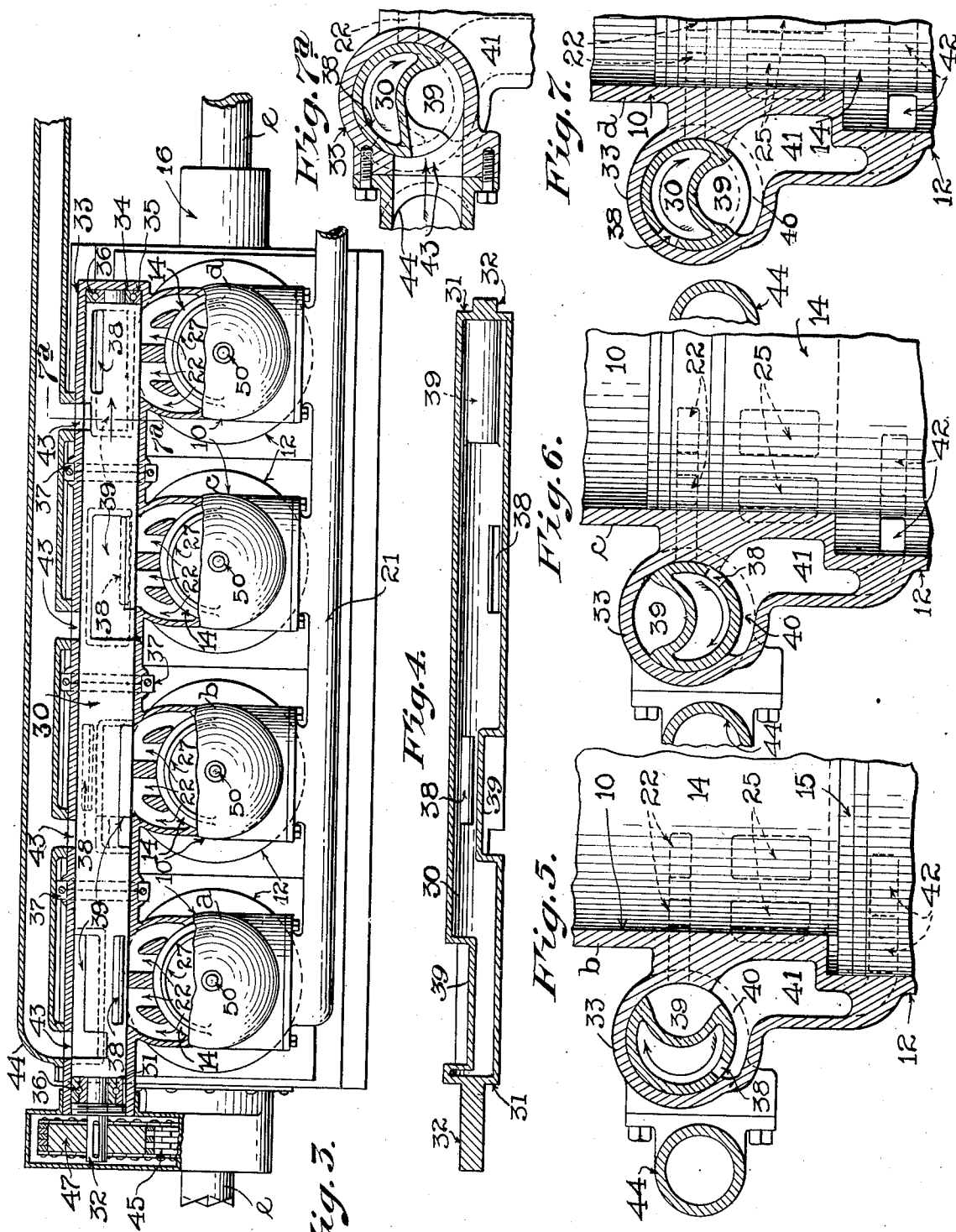
Witnesses
M. S. Crozier,
J. Murphy.

Inventor,
Frederick O. Kilgore
by Jas. H. Lumschill
Attorney.

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4 SHEETS-SHEET 3.



Witnesses:
M. G. Craig
J. Murphy

Inventor,
Frederick O. Kilgore
by Jas. H. Churchill
Attorney.

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4 SHEETS—SHEET 4.

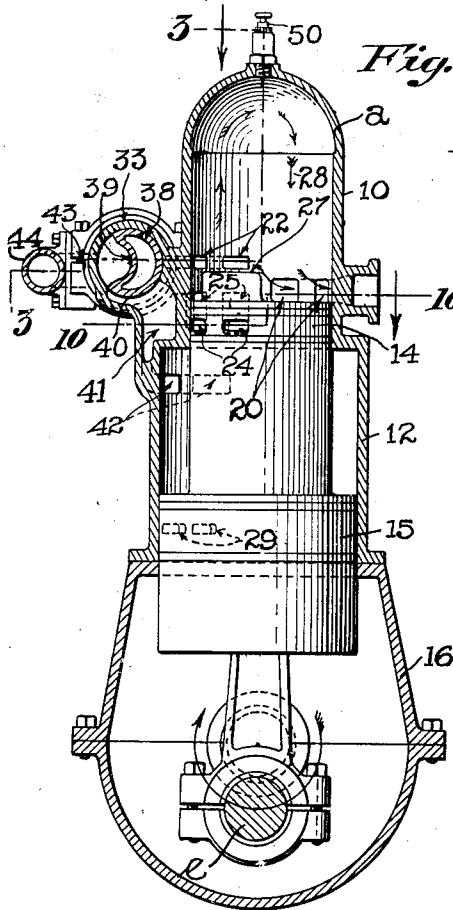


Fig. 8.

Fig. 12.

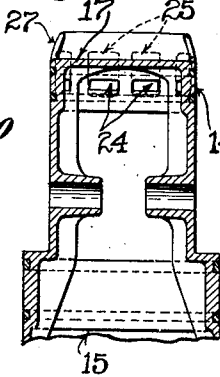


Fig. 11.

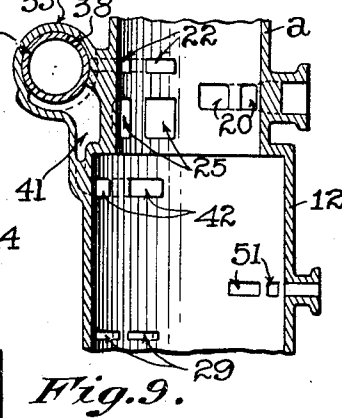
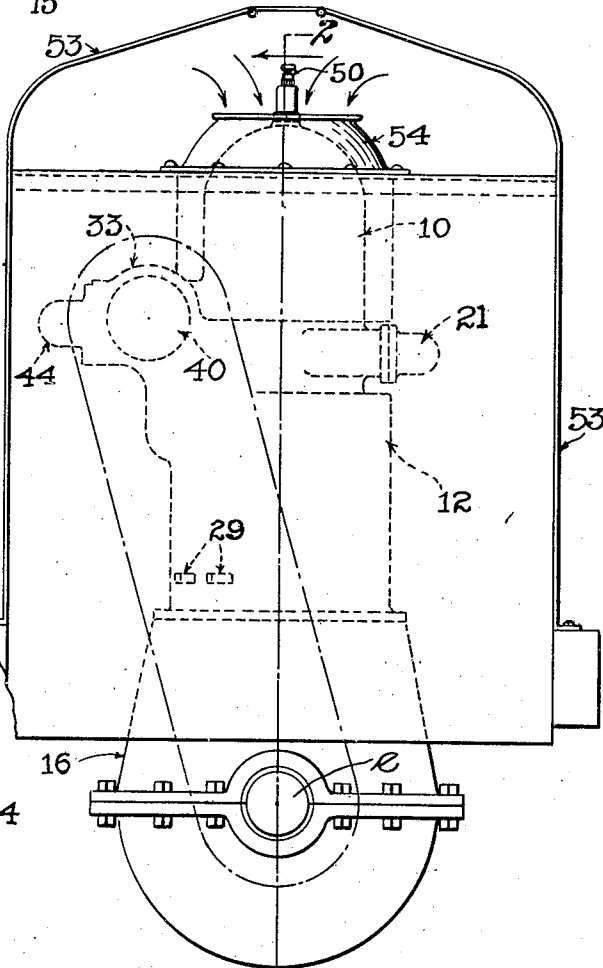
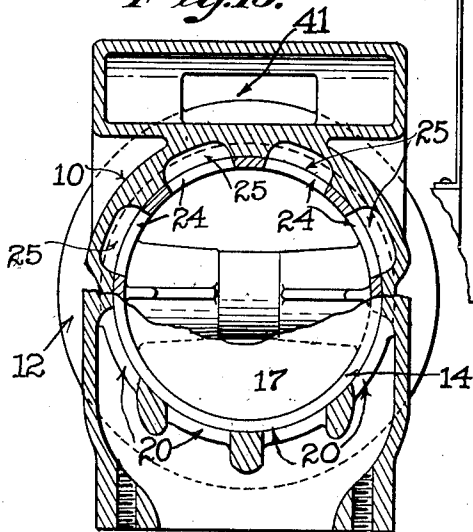


Fig. 9.

Fig. 10.



Witnesses:

M. E. Crozier
J. Murphy

Inventor,
Frederick O. Kilgore
by Jas. H. Churchill
Attorney.

UNITED STATES PATENT OFFICE.

FREDERICK O. KILGORE, OF SOMERVILLE, MASSACHUSETTS.

INTERNAL-COMBUSTION ENGINE.

1,056,690.

Specification of Letters Patent.

Patented Mar. 18, 1913.

Application filed May 28, 1912. Serial No. 700,161.

To all whom it may concern:

Be it known that I, FREDERICK O. KILGORE, a citizen of the United States, residing in Somerville, county of Middlesex, and State of Massachusetts, have invented an Improvement in Internal-Combustion Engines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to an internal combustion engine or motor and is herein shown as embodied in a motor of the two cycle type.

The invention has for its object to provide a motor of the class described, which is economical in fuel consumption and of maximum efficiency, as will be described.

Figure 1 is an elevation of an internal combustion engine or motor embodying this invention. Fig. 2, a vertical longitudinal section of the motor shown in Fig. 1. Fig. 3, a plan with parts in section of the motor shown in Fig. 2, the section being taken on the line 3—3, Fig. 8. Fig. 4 a detail in section of the rotary valve shown in Fig. 3. Figs. 5, 6, 7 and 7*, details in section to show different positions of the rotary valve. Fig. 8, a vertical transverse section of the motor on the line 8—8, Fig. 1. Fig. 9, an end elevation of the motor shown in Fig. 1. Fig. 10, a horizontal section on the line 10—10, Fig. 8. Fig. 11, a vertical section of a modification to be referred to, and Fig. 12, a detail in section of the working piston to be referred to.

In the present instance the invention is shown in an engine comprising four two cycle motors *a, b, c, d*, operatively connected with a crank shaft *e*, and as all of the motors are of like construction a detailed description of one will suffice to enable the invention to be clearly understood.

Referring to Fig. 8, 10 represents the explosion chamber and 12 the compressing chamber of a two step or differential cylinder, containing a two step or differential piston, comprising the working piston 14 which reciprocates in the chamber 10, and the compressing piston 15 which reciprocates in the chamber 12, said pistons being represented as made in one piece. The pistons 14, 15 as herein shown are made hollow and are in open communication with the crank case 16, upon which the cylinders 12 are mounted, and the piston 14 is closed

at its upper end by the head 17, see Figs. 10 and 12.

The chamber 10 is provided at its lower end with one or more gas outlet or exhaust ports 20, which communicate with a gas outlet or exhaust pipe 21, see Fig. 1, and said chamber is also provided near its lower end but above the level of the exhaust port 20, with one or more gas inlet ports 22, which communicate with the compression chamber 12 to receive a charge of explosive medium, such as a mixture of air and gasoline, which mixture will be hereinafter referred to as the fresh gas. The gas inlet port 22 is located above the exhaust port 20, so that on the up stroke of the piston 14, the exhaust port 20 may be closed or substantially closed before the gas inlet port 22 is opened, for a purpose as will be described.

To obtain an economical and efficient working engine or motor, it is desirable that the explosion chamber should be free or substantially free from burnt or dead gases before the fresh gas is admitted therein, and in the present instance, this desirable result is obtained by providing for the admission of pure air, into the explosion chamber, when the exhaust port 20 is opened and the gas inlet closed or substantially closed, so as to scavenge the said explosion chamber with pure air and drive out therefrom all or substantially all of the burnt or dead gases and leave the explosion chamber filled with pure air. This result is accomplished in the present instance by providing the piston 14 below its head with one or more ports 24, see Figs. 8, 10 and 12, in its body portion, which are arranged to register with one or more passages or cavities 25 on the inner side of the explosion chamber 10, so that air under pressure within the hollow piston 14 can pass through the port 24 and passage 25 into the explosion chamber 10, at or about the time the piston 14 has reached the end of its down stroke, and has uncovered the exhaust port 20, preferably on the last end of the down stroke and the beginning of the up stroke of said piston.

The passage 25 in the chamber 10 is arranged below the exhaust port 20, and is made longer than the port 24 in the piston 14, so that on the down stroke of the piston 14, the port 24 may register with the passage 25 and the latter yet be closed by the upper end of the said piston, until the lat-

ter has opened the exhaust port 20, whereupon the upper end of the piston 14 on its further downward movement will uncover the upper end of the passage 25 and connect the latter with the explosion chamber 10. The piston head 17 is provided with a rib 27, which is located at one side of the center of the head and opposite the passages 25, so as to act as a deflector and cause the air forced into the explosion chamber to pass upwardly and then downwardly to the exhaust port 20, as indicated by the arrows 28, see Fig. 8.

The air forced into the explosion chamber, drives all or substantially all of the burnt or dead gases out of the explosion chamber, and leaves the latter filled with pure air when the exhaust port 20 is closed at the beginning of the up stroke of the piston 14, which previously covered the air passage 25 and shut off the supply of air prior to or about the time the exhaust port 20 is closed. Atmospheric air is admitted into the crank case 16 through ports 29 in the chamber 12, which are uncovered on the up stroke of the piston 15. At or about the time the exhaust port 20 is closed, fresh gas under pressure is admitted into the explosion chamber 10 through the inlet or intake port 22, which is controlled by a valve, preferably a hollow rotary valve, which may be constructed as shown in Figs. 1 to 8, so as to supply fresh gas from the usual carbureter or other source of supply, into both the compressing chamber and explosion chamber, or as shown in Fig. 11, to control only the supply of fresh gas from the compression chamber into the explosion chamber.

The rotary valve shown in Figs. 1 to 8, comprises a hollow cylindrical body 30, closed at its ends by heads 31 having journals 32, see Figs. 3 and 4, which are supported by suitable bearings within a cylindrical shell or casing 33, which is represented as composed of a series of sections integral with the cylinders, one for each cylinder. The bearings may be of any suitable construction and are herein shown as ball bearings, and each comprise a member 34, see Fig. 3, fast on one of the journals, and a member 35 secured in fixed position within the casing, said members having interposed between them balls 36 or it might be rollers.

The sections of the casing 33 may be secured together in any suitable manner, as by bands or straps 37.

The hollow valve 30 is provided with a plurality of ports or openings 38, one for each cylinder, which coöperates with the inlet port 22 in said cylinder, see Fig. 3, for the passage of gas from within the hollow valve into the cylinder through the inlet port 22 thereof, and the cylindrical body

portion of the hollow valve is provided with a plurality of reëntrant portions or external dents or passages 39, one for each cylinder, which do not communicate with the interior of the valve body but do register with a port 40 in the valve casing 33, which is connected by a passage 41 and one or more ports 42 with the compression chamber 12. Each external passage or cavity 39 also coöperates with a port 43 in the casing 33, with which is connected a gas supply pipe 44, which leads from the carbureter or other supply of gas, (not shown) and the external passage 39 is made wider at one end, so that it may register with the port 43 at the same time the said external passage registers with the port 40 leading to the compressing chamber as represented in Fig. 7^a.

The rotary valve 30 may be driven from the crank shaft in unison therewith in any suitable manner; as for instance by a link chain 45 passed about sprocket wheels 46, 47 on the crank shaft and valve respectively.

In the operation of the rotary valve, the external passage 39 connects the carbureter or other source of supply with the compressing chamber 12, once for each revolution of the crank shaft, so that on the down stroke of the piston 15, fresh gas is drawn from the source of supply through the inlet pipe 44, port 43, external passage 39, port 40, passage 41, and port 42 into the chamber 12. On the up stroke of the piston 15, the fresh gas in the chamber 12 is compressed therein, as the port 40 is closed by a solid portion of the rotary valve, (see Fig. 8); and when the port 38 in the valve registers with the port 40, the interior of the valve 30 is connected with the compressing chamber 12, whereupon the fresh gas at the given or desired pressure flows from the passage 41 through the ports 40, 38 into the interior of the hollow valve, from which it passes out into that explosion chamber 10 of the motor with whose intake port 22 another port 38 of the rotary valve registers. In the present instance the motor is shown as provided with four differential cylinders with their pistons connected with four cranks of the crank shaft set approximately on the quarter, see Fig. 2, and the position of the ports 38, 39 of the rotary valve coöperating with the four cylinders are represented in Figs. 8, 5, 6 and 7, that is to say, Fig. 8 shows the position of the ports 38, 39 with relation to the motor *a*; Fig. 5 that of motor *b*; Fig. 6 that of motor *c*; and Fig. 7 that of motor *d*.

As shown in Figs. 2 and 8, the motor *a* is exhausting; in Figs. 2 and 5, the motor *b* is about to fire or explode. In Figs. 2 and 6 the motor *c* is compressing, and in Figs. 2 and 7 the motor *d* has fired and its pistons are on their down stroke.

The operation of the motor may be briefly

described as follows: Referring to Fig. 8, the pistons 14, 15 are shown in their lowest position and the rotary valve is shown as cutting off the chamber 12 from the carbureter and as closing the intake port 22. The exhaust port 20 is wide open and the air port 24 in the piston 14 registers with the passage 25 in the chamber 10. The pistons 14, 15 are at the beginning of their up stroke. With the pistons and rotary valve in the positions shown in Fig. 8, air passes from the crank case up through the hollow pistons and through the port 24 and passage 25 into the chamber 10, striking against the deflector 27, by which it is caused to flow up to the top of the chamber and then down to the exhaust ports 20, driving before it the burnt or dead gases from the previous explosion. The air port 24 and passage 25 are opened a sufficient length of time to allow enough air to drive out all or substantially all of the burnt gases and leave the chamber 10 filled or substantially filled with pure air, when the air passage 25 is closed, which is effected slightly in advance of the closing of the exhaust ports by the upwardly moving piston 14. While the air is driving out the burnt gases, the gas inlet is closed or substantially closed, so as to avoid waste of gas, and at or about the time the exhaust port 20 is closed, the rotary valve opens the intake port 22, and fresh gas under pressure of preferably about 5 lbs. is admitted from the hollow rotary valve into the chamber 10, and on the continued upward stroke of the piston 14, said gas is still further compressed until the piston has reached the end of its up stroke and is at the beginning of its down stroke. In the meantime, the fresh gas in the chamber 12 is compressed by the piston 15, until the rotary valve 30 has advanced and brought the port 38 into register with the port 40, whereupon the fresh gas under pressure is forced into the hollow valve. When the piston 14 is beginning its down stroke, the compressed charge of fresh gas mixed with pure air is fired in the usual manner by the spark plug 50 or otherwise, and the explosion drives the pistons down into the position represented in Fig. 8, the exhaust port 20 being opened in advance of the air passage 25 on the last portion of the downward stroke of the piston 14. At or about the time the charge is fired, the external passage 39 in the rotary valve, connects the gas supply pipe 44 with the chamber 12 and fresh gas is again drawn into the said chamber.

It will be seen, that the compressing piston of each motor on its up stroke, forces fresh gas at a given or predetermined pressure into the interior of the hollow valve, which acts as a reservoir to hold the fresh gas under pressure and supply the explosion chamber of each motor with fresh gas

under an initial pressure above the atmosphere, when the gas intake port 22 of each explosion chamber is uncovered.

The initial pressure of the fresh gas admitted into the explosion chamber of each motor is greatly increased by the compression or up stroke of the piston in said chamber, which thereby increases the efficiency of the motor. Furthermore, the fresh gas is admitted into an explosion chamber which is free or substantially free from dead or burnt gases and contains practically only fresh air, consequently the compressed charge in the explosion chamber is exploded under the most favorable conditions, which also serves to increase the efficiency of the motor. It will be observed that on the down stroke of the piston 15 of larger diameter, a large quantity of fresh air is forced into the cylinder 10, which is of smaller diameter, thereby insuring an abundance of fresh air to completely scavenge the cylinder.

By flushing the explosion chamber with pure air while the gas intake port is closed or substantially closed, all the gases in the explosion chamber after an explosion, are displaced by pure air without loss of fresh gas or explosive medium, which serves to obtain a very economical motor. Furthermore the pure air passing up through the hollow pistons, and into and through the explosion chamber serves to assist in cooling the motor. The pressure to which the fresh gas is raised by the piston 15 can be varied by increasing or decreasing the size or diameter of the chamber 12 and of the portion of the piston 14 which extends into the chamber 12.

In Fig. 11, is represented an arrangement in which the fresh gas is admitted directly into the chamber 12 through the inlet port 51 with which the carbureter is connected, and employing a hollow rotary valve which need not have the external passages 39 but has only the port 38. In this arrangement the operation is the same as above described, except that the fresh gas is taken directly from the carbureter through the port 51 which is opened and closed by the piston 15.

In Figs. 1 and 9, I have shown the motor as provided with a system of cooling by air substantially as shown and described in Letters Patent No. 962437 granted to me June 28, 1910 and consisting essentially of a substantially air tight casing 53 having a series of bonnets 54, which surround the chambers 10 and through which air is drawn by a fan not shown in the fly wheel 55, and while it may be preferred to use this system of cooling, it is not desired to limit the invention in this respect as the motor may be cooled by water as now largely practised by providing the cylinders with water jackets.

The engine or motor embodying the above

invention is enabled to work equally as well at high speeds as at low speeds, for the reason that the fresh gas is under pressure before it is admitted into the explosion chamber, which insures a sufficient quantity of fresh gas being admitted to the said chamber even when the intake port is opened for a small space of time when the motor is running at high speeds, and loss of power is avoided by having the explosion chamber free or substantially free from dead or burnt gases. Furthermore the motor is light, durable and inexpensive to maintain on account of the small number of working parts.

Claims:

1. In an internal combustion motor, in combination, a differential cylinder comprising an explosion chamber and a compressing chamber, said explosion chamber having an exhaust port, a gas inlet port located at a higher level than said exhaust port, and an air passage on its inner surface below said exhaust port, a differential piston comprising a hollow upper piston having a head at its upper end and provided with a port in its body portion cooperating with said air passage, and a hollow lower piston attached to said upper piston, a valve casing having a gas inlet port, and a gas outlet port leading to the compressing chamber, a hollow rotary valve provided with an external passage which coöperates with the gas inlet port to connect it with the port leading to the compressing chamber, and having a port coöperating with the gas inlet port for the explosion chamber to supply fresh gas thereto, and coöperating with the port leading to the compressing chamber to connect the latter with the interior of the hollow valve, for the purpose specified.
2. In an internal combustion motor, in combination, a differential cylinder comprising an explosion chamber and a compressing chamber, said explosion chamber having an exhaust port, a gas inlet port located at a higher level than said exhaust port, and an air passage on its inner surface below said exhaust port, a differential piston comprising a hollow upper piston having a head at its upper end and provided with a port in its body portion coöperating with said air passage, and a hollow lower piston attached to said upper piston, a hollow rotary valve controlling the admission of fresh gas from the compressing chamber into it and from it into the explosion chamber, substantially as described.
3. In an internal combustion motor, in combination, a differential cylinder comprising an explosion chamber and a compressing chamber, said explosion chamber being closed at its upper end and having an exhaust port at its lower end, a gas inlet

port at a higher level than said exhaust port and in proximity to the level of said exhaust port, and an air inlet port below said exhaust port, a differential hollow piston in said cylinder open at its lower end and closed at its upper end and having a port in its body portion, the piston in the explosion chamber controlling said air inlet and exhaust ports to permit the same to be open at the same time and allow air to flow through the piston into the explosion cylinder and drive the burnt gases out through the exhaust port, and a rotary valve for closing the said gas inlet port while the exhaust and air inlet ports are open.

4. In an internal combustion motor, in combination, a differential cylinder comprising an explosion chamber and a compression chamber of larger diameter, a differential piston in said chambers, said explosion chamber having an exhaust port, an air inlet port and a gas inlet port, and said compression chamber having a gas port, a rotary valve controlling the gas inlet port to the explosion chamber and the gas port to the compression chamber and coöperating with the gas port for the compression chamber to connect the same with the gas supply on the stroke of the compression piston in one direction and to close said port for the compression chamber for a portion of the stroke of the compression piston in the opposite direction to cause the fresh gas to be compressed in the compression chamber, for the purpose specified.

5. In an internal combustion motor, in combination, a differential cylinder comprising an explosion chamber and a compression chamber of larger diameter, a differential piston in said chambers, said explosion chamber having an exhaust port and a gas inlet port controlled by its piston, and said compression chamber having a gas port, a valve casing having a port connected with a supply for fresh gas, and a second port connected with the gas port of the compression chamber to supply fresh gas to the latter, a hollow valve closed at its ends and provided with a body portion having an external passage non-communicating with its interior and having a port communicating with its interior, said hollow valve being mounted to rotate in said casing and coöperating with the ports of said valve casing to connect the same by means of said external passage, to thereby admit gas from the supply into the compression chamber on the suction stroke of its piston and to close the second port for said valve casing during a portion of the return stroke of said compression piston, to thereby effect compression of the fresh gas in the compression chamber while the latter is cut off from the interior of the hollow valve, and thereafter to connect the port in the body portion of the hollow valve

with the second port of the valve casing and thereby admit the gas under compression in the compression chamber into the hollow valve, for the purpose specified.

5 6. In an internal combustion motor, in combination, a differential cylinder having an explosion chamber and a gas compression chamber of larger diameter than said explosion chamber, the latter being closed at its
10 upper end and having at its opposite end an exhaust port, an air inlet port, and a gas inlet port located above the level of the said air inlet and exhaust ports, a hollow differential piston in said cylinder open at its
15 lower end and having a port through its body portion near its upper end to cooperate with said air inlet port and connect the latter with the interior of said pistons, a valve casing located near the lower end of
20 the explosion chamber and the upper end of the compression chamber and provided with a port leading to the gas inlet port of the explosion chamber and with a port leading to the compression chamber, and a hollow
25 valve mounted to rotate in said valve casing and cooperating with the ports thereof, substantially as described.

7. In an internal combustion motor, in combination, a plurality of differential cylinders each having an explosion chamber
30 provided with a gas inlet, a separate exhaust and a separate air inlet, and each having a gas compression chamber provided with a gas passage, a hollow differential piston in
35 each of said cylinders open at its lower end and having a port in its body portion which cooperates with the air inlet port of the explosion chamber to connect the latter with the interior of said piston, and a hollow rotary
40 valve cooperating with the gas passages of the compression chambers to open the same and admit fresh gas therein on the stroke of their pistons in one direction and to close the said passages for a portion of
45 the stroke of said pistons in the opposite direction to cause the gas in said compression chambers to be compressed therein, and cooperating with said gas inlets for the explosion chambers to admit compressed gas
50 from the compression chamber of one cylinder into the explosion chamber of another cylinder, whereby the explosion chambers of each differential cylinder is supplied with fresh gas under pressure which is further
55 compressed by the piston in said explosion chamber, substantially as described.

8. In an internal combustion motor, in combination, a differential cylinder comprising an explosion chamber and a compressing
60 ing chamber, said explosion chamber having an exhaust port and an air inlet port near its lower end, and having a separate gas inlet port, and said compression chamber having a gas passage, a differential piston
65 in said cylinder, the piston in said ex-

plosion chamber controlling said exhaust and said air inlet to permit the explosion cylinder to be substantially cleared of the burnt gases and filled with substantially pure air when said exhaust and air inlet
70 ports are closed on one stroke of said piston, and a hollow rotary valve for substantially closing said gas inlet port when said exhaust port is open and for closing the gas passage of the compression chamber during
75 a portion of the upstroke of the compression piston.

9. In an internal combustion motor, in combination, a differential cylinder having an explosion chamber provided with a gas
80 inlet, a separate exhaust and a separate air inlet, and a gas compressing chamber having a gas inlet and gas outlet, a hollow rotary valve controlling the admission of compressed gas into said explosion chamber
85 and the admission of uncompressed gas into said compressing chamber and cooperating with the latter to effect compression of the gas in said compression chamber, and a differential piston in said chambers, the piston
90 in the explosion chamber controlling said air inlet and exhaust, substantially as described.

10. In an internal combustion motor, in combination, a plurality of cylinders, each
95 having an explosion chamber closed at one end and provided with a gas inlet and an exhaust port near its other end, and each having a gas compression chamber provided with a gas passage, pistons in said explosion
100 and compression chambers, and a rotary valve cooperating with the gas passages of the compression chambers to admit fresh gas into said chambers on the stroke of their pistons in one direction and to close said
105 passages and effect initial compression of said gas within said compression chambers during a portion of the stroke of their pistons in the opposite direction, and cooperating
110 with the gas inlets of said explosion chambers to admit the initially compressed gas into said explosion chambers, to be further compressed therein, for the purpose specified.

11. In an internal combustion motor, in combination, a differential cylinder having
115 an explosion chamber and a gas compressing chamber, of larger diameter than said explosion chamber, a supply of gas connected with the gas compressing chamber, a differential piston in said differential cylinder, said explosion chamber having an exhaust
120 port, an air inlet port, and a gas inlet port, a rotary valve cooperating with the gas compressing chamber to close the same and effect the compression therein of fresh
125 gas during a portion of the up stroke of its piston, and with said gas inlet port to admit gas under pressure into said explosion cylinder, after the air inlet and the exhaust
130

port have been substantially closed by the piston in the explosion chamber, substantially as described.

12. In an internal combustion motor, in combination, a differential cylinder having an explosion chamber closed at one end and having a gas inlet port and an exhaust port near its other end, and having a compression chamber of larger diameter provided with a gas passage, a differential piston in said chambers, and a hollow rotary valve having an external passage non-communicating with its interior and cooperating with the gas passage of the compression chamber to admit fresh gas into said compression chamber on the suction stroke of the piston therein, said rotary valve also cooperating with said gas passage to close the same during a portion of the return stroke of the piston in the compression chamber to effect compression of the fresh gas in said compression chamber and thereafter to connect said compression chamber with the interior of the hollow valve, for the purpose specified.

13. In an internal combustion motor, in combination, a differential cylinder having an explosion chamber closed at one end and having a gas inlet port and an exhaust port near its other end, and having a compression chamber of larger diameter provided with a gas passage, a differential piston in said chambers, and a hollow rotary valve cooperating with the gas passage of the combustion chamber to close the same during a portion of the return stroke of the piston in the compression chamber, to thereby effect compression of the fresh gas in said compression chamber, and thereafter to connect said compression chamber with the interior of the hollow valve, for the purpose specified.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

FREDERICK O. KILGORE.

Witnesses:

JAS. H. CHURCHILL,
J. MURPHY.