March 15, 1938. G. W. MEREDITH **2,110,888**

INTERNAL COMBUSTION ENGINE

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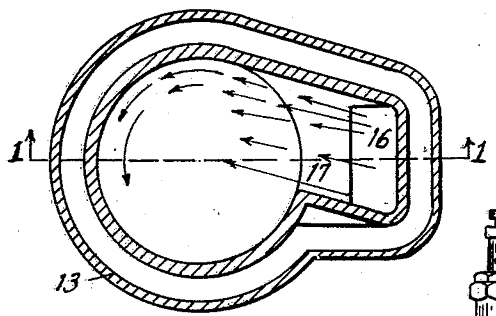

Fig. 2.

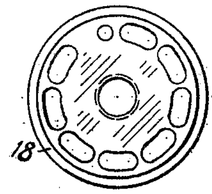

Fig. 3.

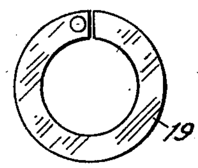

Fig. 4.

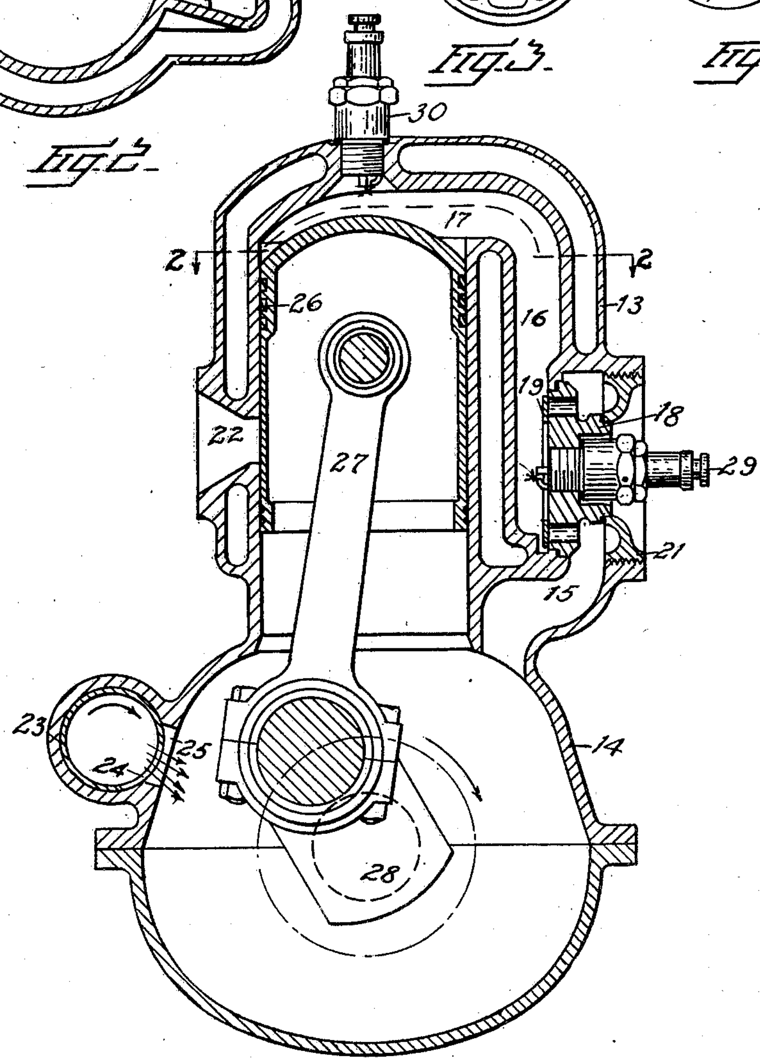

Fig. 1.

Inventor
George W. Meredith

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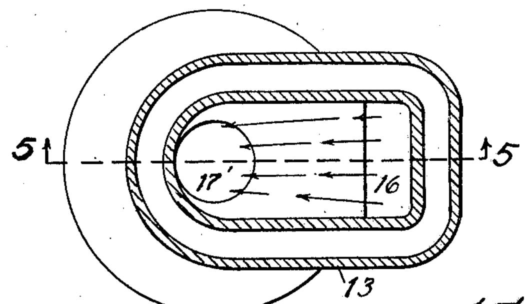

Fig. 6.

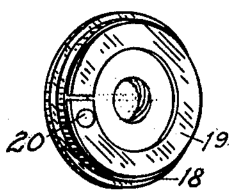

Fig. 7.

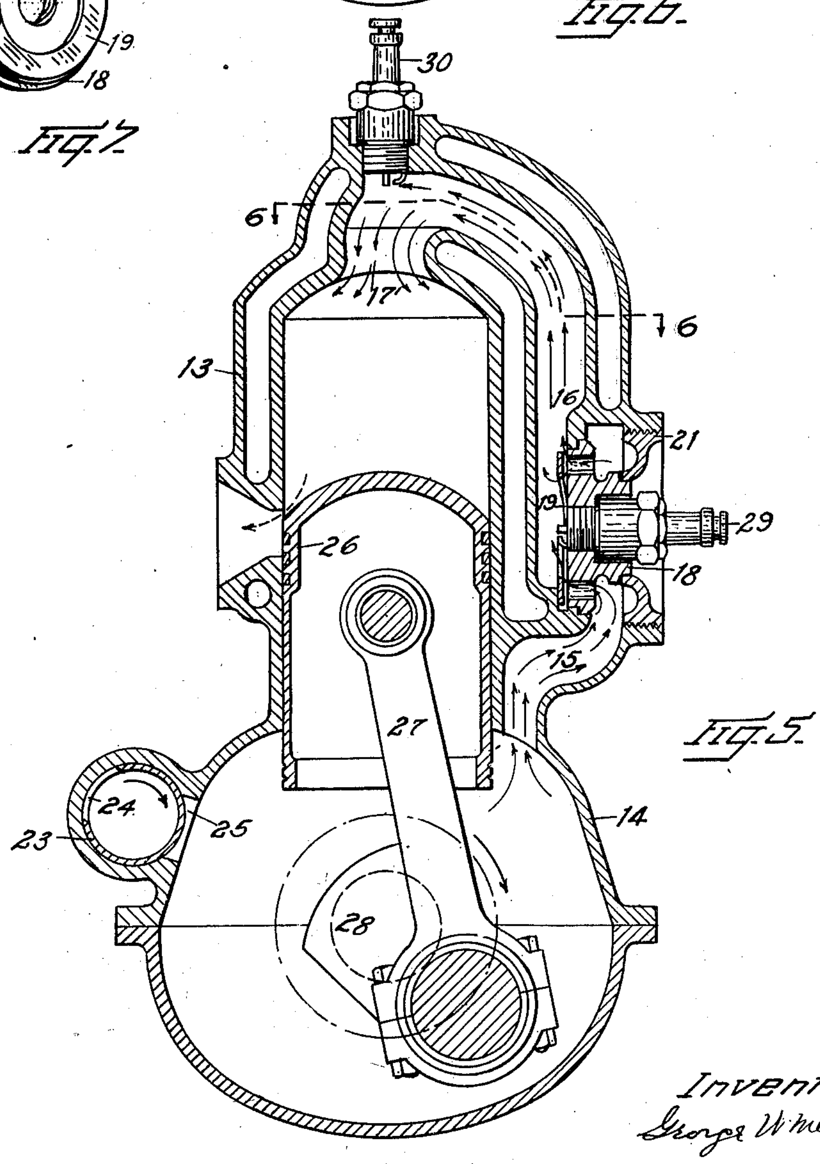

Fig. 5.

Inventor
George W. Meredith

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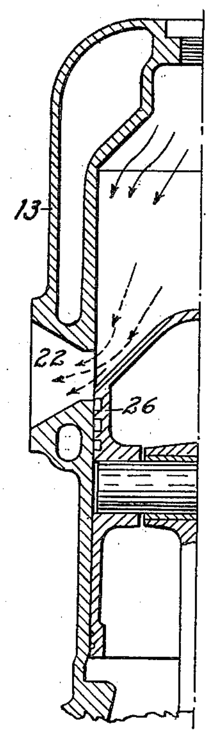

Fig. 10

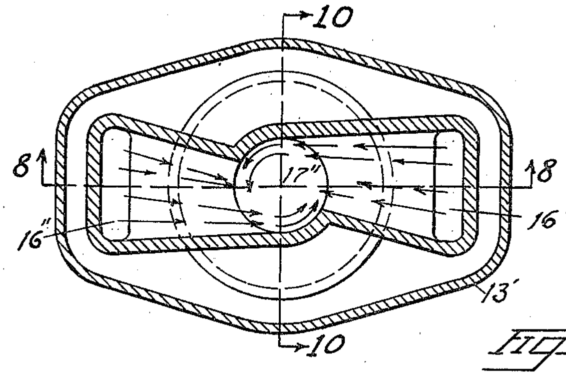

Fig. 9

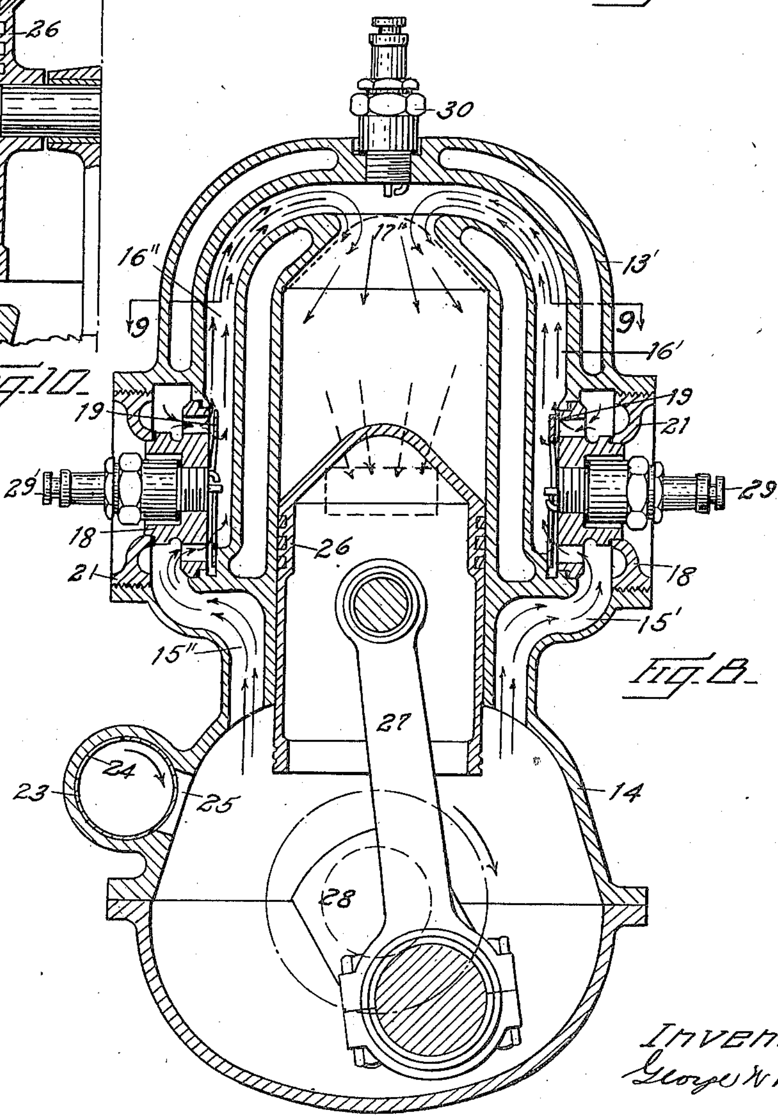

Fig. 8

Inventor
George W. Meredith

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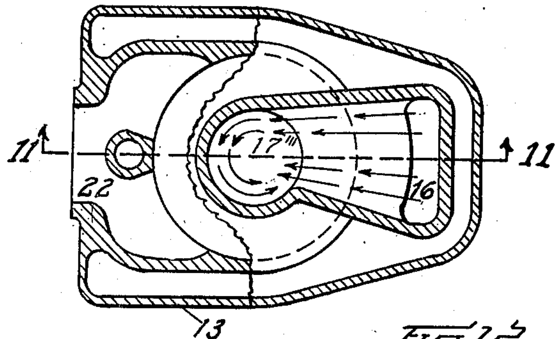

Fig. 12.

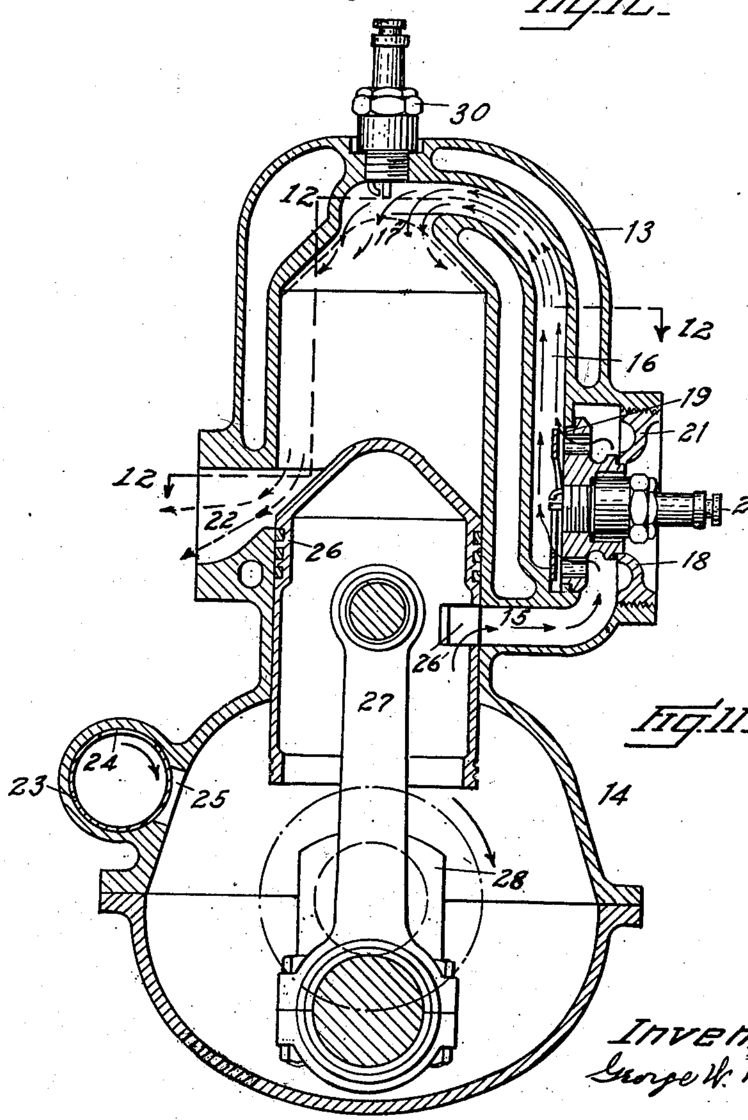

Fig. 11.

Inventor
George W. Meredith

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UNITED STATES PATENT OFFICE

2,110,888

INTERNAL COMBUSTION ENGINE

George W. Meredith, Cincinnati, Ohio

Application October 22, 1934, Serial No. 749,369

8 Claims. (Cl. 123—73)

The two-cycle type of gas engine (the term "gas engine" being hereinafter employed as synonymous with "internal-combustion engine"), is notoriously deficient in flexibility and shows poor fuel economy when operated at other than its full load capacity. One of its major faults is a tendency to miss explosions at low throttle. This latter trouble is due to the presence of a considerable proportion of products of combustion in the content of the cylinder. It is well known in the art that a partial vacuum in the cylinder, produced by throttling the incoming charge, will draw into the cylinder exhaust gases from the exhaust manifold. On the other hand, the compression pressure in the cylinder of a two-cycle gas engine is the same at low throttle as when the cylinder receives the maximum charge of fresh mixture. For this reason, other factors being the same, the higher compression of the two-cycle at low throttle, as compared to the four-cycle at low throttle, tends toward a higher thermal efficiency for the two-cycle. The presence of a considerable proportion of exhaust gases in the cylinder tends toward difficulty of ignition and slow combustion when the mixture is ignited. Poor fuel economy in the average two-cycle gas engine is due, in a great measure, to the escape of fresh mixture out through the exhaust ports during the early part of the compression stroke.

In general, the object of my invention is to overcome the faults above enumerated. By providing means whereby the igniter is certain to be surrounded by a mixture of fuel and air undiluted by exhaust gases, regardless of the throttle position, I ensure ignition every time the igniter functions. An object of my invention is to promote turbulence, thereby to ensure an intimate mixture of the fuel and the air.

To secure more or less stratification and, thereby, a certain measure of isolation between the fresh charge and the residual exhaust gases, is another object of my invention. Intimately associated with stratification is the provision of unidirectional flow of exhaust gases followed by the entering charge, which is a further object of my invention. Stratification accomplishes another object of my invention namely; the minimizing of dilution of the fresh mixture with residual exhaust gases.

The engine herein illustrated and described is similar in certain respects to that which is the subject of my prior application filed Aug. 31, 1934 and bearing Serial No. 742,277, series of 1925, and to engines illustrated and described in two other applications filed concurrently with this. However, while the engines shown in the other applications referred to employ a piston controlled port or ports for the entrance of the precompressed fresh mixture from the crankcase to the cylinder, the engine of the present application employs a special check valve for this purpose.

In processing my invention I provide within the lateral wall of the cylinder a conduit communicating at one end with the crankcase and at its opposite end with the space between the closed end of the cylinder and the piston when the piston is at the end of its compression stroke. I so divide this conduit by means of a special pneumatically operated automatic valve that that end of or portion of the conduit in communication with the cylinder immediately within the cylinder head comprises the major portion of the compression space. Within this somewhat attentuated compression space I place two or more igniters, one at the closed end of the cylinder and the others at that end of the compression space in proximity to the valve in the conduit. In one form of my invention I employ a single conduit fitted with a valve therein. In an alternate form of my invention I employ two conduits with a valve in each, and an igniter in the closed end of the cylinder and igniters in proximity to the valves in each of the conduits. I am aware that a conduit in the lateral wall of the cylinder in which is comprised a portion of the compression space has been previously employed. I am also aware that an automatic valve between the cylinder and the precompression chamber has been used heretofore. But I do not believe that both have been employed heretofore in the exact combination herein described and illustrated in the drawings which accompany this specification.

In the accompanying drawings, I illustrate three types of entrance from the conduits into the cylinder and engines having cylinders provided with one conduit together with one engine in which two conduits are provided in the lateral wall of the cylinder. One type of entrance is along a plane at a right angle to the axis of the cylinder. Another type of entrance is through a port in the cylinder head and surrounding the axis of the cylinder extended. A third type of entrance is a modification of the others and combines the features of both. The latter type of entrance is that employed in the cylinder provided with two conduits.

In the drawings:

Fig. 1 is an elevation in section of one form of my invention, the section being taken along line 1—1 of Fig. 2.

Fig. 2 is a plan view in section of the engine of Fig. 1, the section being taken along line 2—2 of Fig. 1.

Fig. 3 is an elevation of the seat body of the automatic valve employed to control the entrance of the mixture from the crankcase into the cylinder.

Fig. 4 is an elevation of the spring flap valve employed to close the openings in the valve seat body shown in Fig. 3.

Fig. 5 is an elevation in section of one alternate form of my invention, the section being taken along line 5—5 of Fig. 6.

Fig. 6 is a plan in section of the engine of Fig. 5, the section being taken along line 6—6 of Fig. 5.

Fig. 7 is an elevation in perspective of the automatic valve, of which the seat body and the flap valve are shown in Figs. 3 and 4, to illustrate the method of attachment of the flap to the valve body.

Fig. 8 is an elevation in section of a form of my invention in which the cylinder is provided with two conduits in the lateral walls thereof and having an entrance into the cylinder from the conduits which is common to both conduits and of a form which is a combination of those employed in the engines of Figs. 1 and 5. The section is taken along line 8—8 of Fig. 9.

Fig. 9 is a plan in section of the engine of Fig. 8, the section being taken along line 9—9 of Fig. 8.

Fig. 10 is a fragmentary half section of the engine of Fig. 8 being an elevation at a right angle to that of Fig. 8 and along line 10—10 of Fig. 9.

Fig. 11 is an elevation in section of an engine having a cylinder provided with a single conduit and having an entrance from the conduit into the cylinder of a type similar to the engine of Fig. 8, the section being taken along line 11—11 of Fig. 12.

Fig. 12 is a plan in section of the engine of Fig. 11, the section being taken along line 12—12 of Fig. 11 and through the entrance from the conduit into the cylinder, and through the exhaust port.

In the figures, in which similar numerals designate similar parts throughout the several drawings, the cylinder is designated by the numeral 13 and the crankcase attached thereto by the numeral 14. In the lateral wall of the cylinder in Figs. 1, 5 and 11 is the by-pass 15. In Fig. 8, in which two are provided, they are designated by numerals 15′ and 15″. Higher up toward the closed end of the cylinder there is provided in the lateral wall thereof the conduit 16 (Figs. 1, 5 and 11), and conduits 16′ and 16″ in Fig. 8. The conduits are in communication with the space between the closed end of the cylinder and the piston when piston 26 is at the end of its compression stroke, which it is shown as approaching in Fig. 1, by way of ports 17, 17′, 17″ and 17‴ in the various figures. Communication between by-pass 15 and conduit 16 and between by-passes 15′ and conduit 16′ and 15″ and conduit 16″ is through the automatic valve comprised of the seat body 18 to which is attached the spring flap valve 19 by means of bolt 20. Seat body 18 is held in place by nut 21.

Through that wall of the cylinder diametrically opposite the conduits there is provided the exhaust port 22, which is uncovered by piston 26 as the piston approaches the end of its power stroke. In the wall of crankcase 14, and rotatable therein, is the tubular valve 23 which is rotated at crankshaft speed through the medium of gears or a chain. In the wall of valve 23 is provided a port 24 adapted to register with port 25 provided in the wall of the crankcase. The piston 26 is linked to the crankshaft 28 by means of connecting-rod 27. Ignition is provided by the spark plug 29 in proximity to the point of entrance of the mixture from by-pass 15 through the valve 18 to the conduit 16. In the engine of Fig. 8 are the spark plugs 29 and 29′, similarly located. A second point of ignition is provided by means of spark plug 30, located in the center of the cylinder head.

In the operation of my improved engine, the cycle is practically the same as that of any crankcase compression two-stroke cycle engine, ordinarily operated on gasoline. Entrance of the mixture into the crankcase is through valve 23 from which it passes through ports 24 and 25 as indicated by the arrows in Fig. 1. This valve is closed by port 24 rotating out of registration with port 25 about 20° of crank angle after the piston 26 has started on its power stroke. Flap valve 19 is held against seat body 18 by the pressure in the cylinder and the mixture contained in the crankcase is trapped therein and compressed to about 10 pounds per square inch. As the piston approaches the end of its power-stroke exhaust port 22 is uncovered as shown in Figs. 5, 8 and 11. Since but a few ounces of pressure is sufficient to force flap valve 19 away from its seat on body 18, when the pressure in the cylinder falls below that in the crankcase, fresh mixture will pass through by-pass 15 or 15′, 15″ through the valve to conduit 16 or 16′, 16″ and thence into cylinder 13. So soon as pressure on both sides of the valve is equalized the spring tension of the flap 19 will force it to its seat. On the next stroke of the piston the exhaust port 22 is closed and the mixture compressed and ignited as shown in Fig. 1.

In the figures, fresh mixture of fuel and air is indicated by arrows having shanks comprised of solid lines. The flow of the exhaust gases is shown by arrows with shanks comprised of broken lines. In Figs. 2, 9 and 12, the exits from the conduits into ports 17′, 17″ and 17‴ are directed toward the walls of these ports in order that the gases, as they enter the ports, may be constrained to follow paths tangential to the port walls. The object of promoting this tangential motion is to induce turbulence of the mixture, thereby assuring a more thorough distribution of the fuel throughout the air than if turbulence were not so induced. It is well known that the more intimate the mixture, the more even and more rapid will be combustion following ignition.

As the engine throttle is closed, the quantity of mixture entering the crankcase is reduced, the quantity corresponding to the position of the throttle. As the throttle is closed, there is less mixture to be compressed in the crankcase and there will be a smaller quantity transferred from the crankcase to the cylinder, than when the throttle is wide open. While, at full throttle, there will be sufficient mixture entering the cylinder to displace the majority of the exhaust gases, at "low throttle", a considerable proportion of exhaust gas to new mixture will remain in the cylinder. In the ordinary two-cycle engine, the residual exhaust gas will mix with the charge of fresh mixture resulting in the dilution of the mixture by the exhaust and a mixture of the two which will not ignite readily. In my improved engine, the residual exhaust gases will merely confine the fresh mixture in that end of the conduit in the neighborhood of the valve. Thus the mixture and the exhaust gas will occupy different strata. The result will be that new mixture, undiluted by exhaust gases, will surround igniter 29, even when the throttle is so nearly closed that the engine will develop just enough power to carry its friction load. Since there will be an igniter surrounded by ignitible mixture regardless of the throttle position, ignition at low throttle is assured and the engine will run smoothly when idling.

"Four-cycling", ignition but once in two revolutions of the crankshaft, at low throttle, a common fault of the two-cycle engine, is avoided in my invention. The use of two igniters, one at each end of the compression space, or three igniters in the two-conduit engine, shortens the period of inflammation, assuring higher pressure at the beginning of the power stroke and a greater mean effective pressure than if but one igniter were to be employed. This refers to ignition of a full charge or when ignitible mixture surrounds the igniter in the center of the cylinder head as well as that at the valve.

Because of the stratification of the charge, and the greater linear path between the inlet and the exhaust port as compared with the two-cycle as customarily manufactured, there is reduced materially the loss of combustible through the exhaust port during the entrance of the mixture into the cylinder. Much of the poor economy of the ordinary two-cycle is due to this loss.

In the two-cycle of the ordinary type, induction into the crankcase does not begin until after the piston has covered the inlet port from the by-pass. Since the height of this port is customarily equal to one ninth of the stroke of the piston, but 90 percentum of the stroke is effective for induction of new charge into the crankcase. In the engine herein described and illustrated in the accompanying drawings, the induction stroke is effective immediately the flap valve closes. Since this is practically at the beginning of the compression stroke, the volumetric efficiency of my engine is superior to that having only a piston controlled by-pass port. Because of this greater volumetric efficiency and the minimizing of loss of mixture through the exhaust port, a mean effective pressure closely approximating that of the four-cycle engine is secured. Thus I secure, in my invention, practically double the power of a four-cycle of the same piston displacement at the same speed.

I claim:

1. In a two-cycle gas engine including a cylinder and a crankcase attached thereto, a cylinder head on the cylinder, a piston in the cylinder, a compression space provided between the piston and the cylinder head at the end of the stroke, the cylinder walls provided with a longitudinal passage therein, said passage being parallel to the axis of the cylinder, said passage being open to the compression space continuously, thereby providing an extension to the compression space, a valve at that end of the passage farthest from the end of the cylinder, the valve of the automatic type controlled by pressure differences on the opposite sides of the valve, the valve adapted to admit gas from the crankcase into the passage and to prevent the return of gas from the passage into the crankcase, an igniter at the entrance to the passage from the crankcase, said igniter surrounded by the valve and a second igniter in that end of the cylinder opposite the crankcase.

2. In a two-cycle gas engine including a cylinder and a crankcase attached thereto, a cylinder head on the cylinder, a piston in the cylinder, a compression space provided between the piston and the cylinder head at the end of the stroke, the cylinder walls provided with longitudinal passages therein, said passages being parallel to the axis of the cylinder, said passages being open to the compression space continuously, thereby providing extensions to the compression space, valves in those ends of the passages farthest from the end of the cylinder, the valves of the automatic type, controlled by pressure differences on opposite sides of the valves, the valves adapted to admit gas into the passages and to prevent the return of gas from the passages into the crankcase, igniters at the entrances of the passages from the crankcase, and an igniter at that end of the cylinder opposite the crankcase.

3. In a two-cycle gas engine including a cylinder and a crankcase attached thereto, a cylinder head on the cylinder, a piston in the cylinder, a compression space provided between the piston and the cylinder at the end of the stroke, the cylinder walls provided with longitudinal passages therein, said passages being parallel to the axis of the cylinder, said passages being open to the compression space continuously, thereby providing extensions to the compression space, valves in those ends of the passages farthest from the end of the cylinder, the valves of the automatic type controlled by pressure differences on opposite sides of the valves, the valves adapted to admit gas into the passages from the crankcase and to prevent the return of gas from the passages into the crankcase, and igniters in the passages at the entrances from the crankcase into the passages.

4. In a two-cycle gas engine including a cylinder and a crankcase attached thereto, a cylinder head on the cylinder, a piston in the cylinder, a compression space provided between the piston and the cylinder head at the end of the stroke, the cylinder wall provided with a longitudinal passage therein, said passage being parallel to the axis of the cylinder, said passage being open to the compression space continuously, thereby providing an extension to the compression space, a valve at that end of the passage farthest from the cylinder head, the valve of the automatic type controlled by pressure differences on the opposite sides of the valve, the valve adapted to admit gas from the crankcase into the passage and to prevent the return of gas from the passage into the crankcase, the cylinder provided with an entrance port from the passages surrounding the axis of the cylinder extended, an igniter in the passage at the entrance from the crankcase into the passage, and a second igniter in the entrance port from the passage.

5. In a two-cycle gas engine including a cylinder and a crankcase attached thereto, a cylinder head on the cylinder, a piston in the cylinder, a compression space provided between the piston and the cylinder head at the end of the stroke, the cylinder wall provided with a longitudinal passage therein, the passage being parallel to the axis of the cylinder, said passage being open to the compression space continuously, thereby providing an extension to the compression space, a valve at that end of the passage farthest from the

cylinder head, the valve of the automatic type controlled by pressure differences on the opposite sides of the valve, the valve adapted to admit gas from the crankcase into the passage and to prevent the return of gas from the passage into the crankcase, the cylinder provided with an entrance port from the passage surrounding the axis of the cylinder extended, and that portion of the passage leading into the entrance port directed toward the lateral wall of the entrance port.

6. In a two-cycle gas engine including a cylinder and a crankcase attached thereto, a cylinder head on the cylinder, a piston in the cylinder, a compression space provided between the piston and the cylinder head at the end of the stroke, the cylinder wall provided with longitudinal passages therein, the passages being parallel to the axis of the cylinder, said passages being open to the compression space continuously thereby providing an extension to the compression space, valves at those ends of the passages farthest from the cylinder head, the valves of the automatic type controlled by pressure differences on opposite sides of the valves, the valves adapted to admit gas from the crankcase into the passages and to prevent the return of gas from the passages into the crankcase, the passages provided with a common entrance into the cylinder, and the entrance surrounding the axis of the cylinder extended.

7. In a two-cycle gas engine including a cylinder and a crankcase attached thereto, a cylinder head on the cylinder, a piston in the cylinder, a compression space provided between the piston and the cylinder head at the end of the stroke, the cylinder wall provided with longitudinal passages therein, the passages being parallel to the axis of the cylinder, said passages being open to the compression space continuously, thereby providing an extension to the compression space, valves at those ends of the passages farthest from the cylinder head, the valves of the automatic type controlled by pressure differences on opposite sides of the valves, the valves adapted to admit gas from the crankcase into the passages and to prevent the return of gas from the passages into the crankcase, the passages provided with an entrance port into the cylinder common to all, said entrance port surrounding the axis of the cylinder extended, and those portions of the passages leading into the entrance port directed toward the lateral wall of the entrance port.

8. In a two-cycle gas engine including a cylinder and a crankcase attached thereto, a piston in the cylinder, a cylinder head on the cylinder, a compression space provided between the piston and the cylinder head at the end of the stroke, the cylinder wall provided with a longitudinal passage therein, said passage being parallel to the axis of the cylinder, the passage being open to the compression space continuously, thereby providing an extension of the compression space, a port provided in the wall of the cylinder, a channel provided in the wall of the cylinder, the channel extending outwardly from the cylinder port, a port provided in the wall of the piston, the piston port adapted to register with the cylinder port when the piston has approached the end of its power stroke, thereby providing communication from the crankcase to the channel, a valve at that end of the passage farthest from the end of the cylinder, the valve of the automatic type controlled by pressure differences on the opposite sides of the valve, the valve adapted to admit gas from the channel into the passage, and to prevent the return of gas from the passage into the channel, and igniter at the entrance from the channel to the passage, said igniter surrounded by the valve, and a second igniter in that end of the cylinder opposite the crankcase.

GEORGE W. MEREDITH.