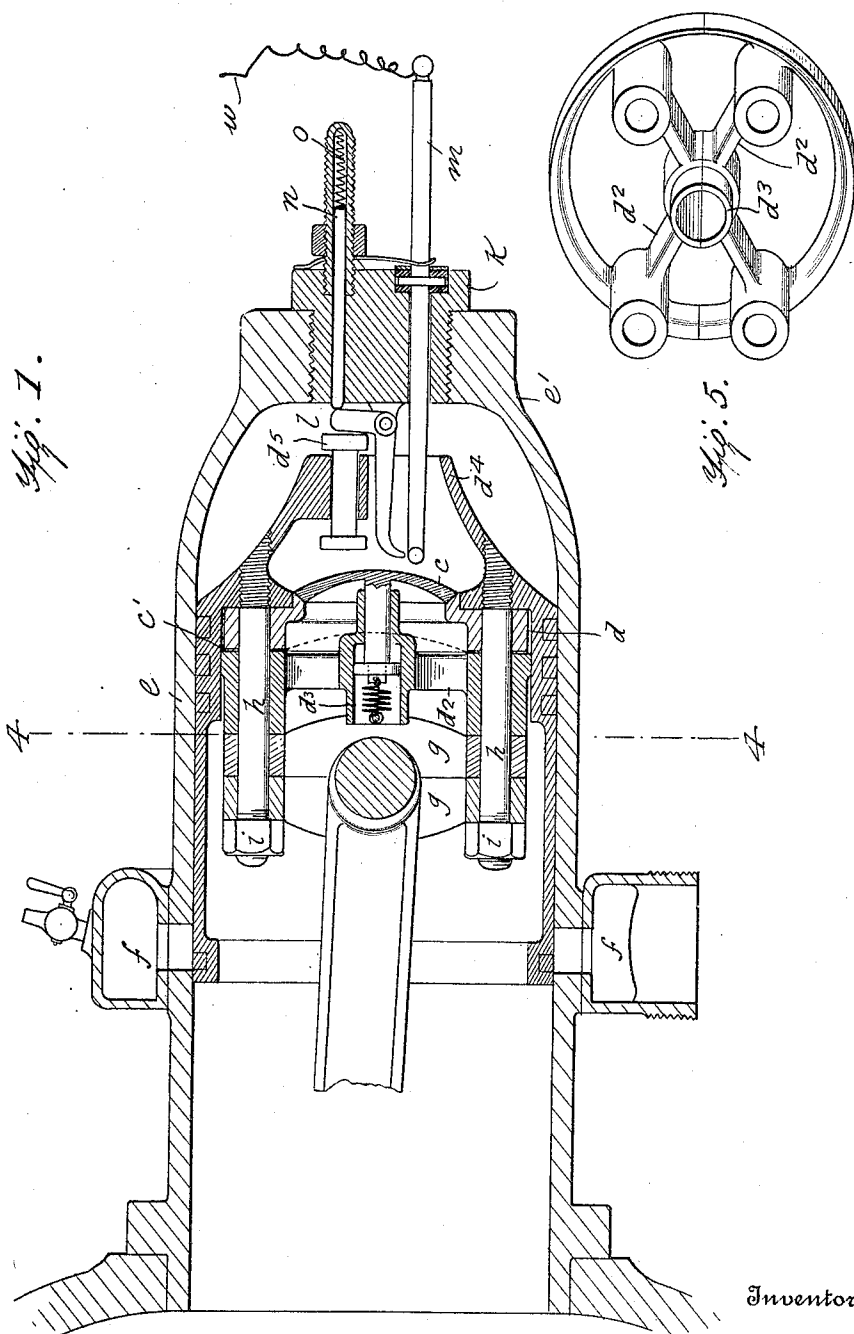


C. E. DURYEA.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED APR. 28, 1910.

1,107,501.

Patented Aug. 18, 1914.

2 SHEETS—SHEET 1.



Witnesses

L. H. Schmidt.
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By

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2 SHEETS—SHEET 2.

Fig. 2.

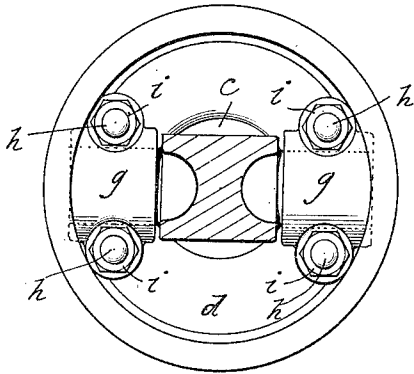


Fig. 3.

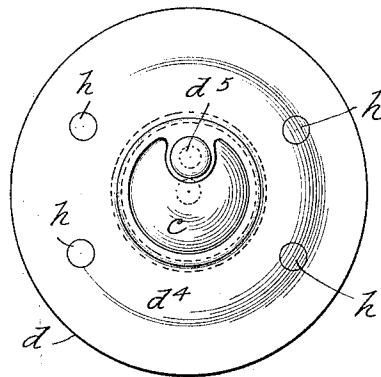
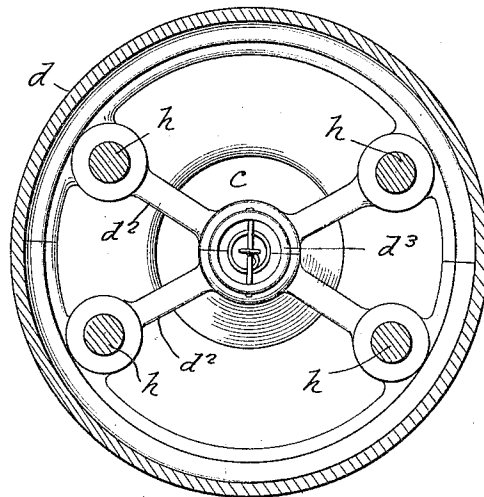


Fig. 4.

Witnesses

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,107,501.

Specification of Letters Patent.

Patented Aug. 18, 1914.

Application filed April 28, 1910. Serial No. 558,235.

To all whom it may concern:

Be it known that I, CHARLES E. DURYEA, a citizen of the United States of America, and resident of Reading, in the State of Pennsylvania, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates to the class of internal combustion engines commonly termed "two-cycle" wherein the piston uncovers an exhaust port near the end of the working stroke and wherein the next charge is, by the same motion of the piston, lightly compressed in the crank box and by this compression is transferred to the cylinder ready for compression by the piston on its return stroke.

The objects of my invention are the overcoming of some of the defects of the usual type of two-cycle engine as well as the attainment of speeds usually considered beyond the practical range of this class of engines. Among these objects may be mentioned means for insuring more complete introduction of explosive mixture or air into the crank box, more direct transfer (and with greater completeness) of the charge to the firing chamber, better cooling of the piston head and cylinder head, less admixture of the new charge with the old during the expulsion of the old and admission of the new, positive ignition of the new charge at the right time and place, simplification of the ignition system and of the construction of the engine, particularly with regard to the heated condition under which a high speed engine, especially if air cooled, must work, and a number of other objects which will appear in the specifications herewith. I accomplish these objects by the mechanism shown in the accompanying drawings in which—

Figure 1 is a sectional elevation of the parts embodying my present improvements and such other parts as are necessary to a proper understanding thereof. Fig. 2 is an end view looking at the interior of the piston. Fig. 3 is an end elevation of the opposite end of the piston removed. Fig. 4 is an enlarged cross section on the line 4—4 of Fig. 1. Fig. 5 is a perspective view of the mounting and housing for the spring.

Similar letters refer to similar parts.

The explosive charge is admitted in the usual way from any preferred form of carbureter to the crank box.

From the crank box *h'* the mixture is passed through a valve *c* in the head *d* of the piston. It is well known that the center of the piston is the place most difficult to cool in most engines. By passing the fresh mixture through it, this objection is overcome. Here I fit a very large valve *c* and make this of spheric section so that it will take the pressure of the explosion with very little amount of metal. Further I support this valve *c* and stem well up into the spheric portion so the weight of the end of the stem and the spring attached thereto, balances the weight of the head and the valve has no tendency to drop down at the head and fail to strike its seat properly. This mounting fits it to the horizontal type of motor without placing the valve crosswise the axis of the piston as has been done. I provide in this mounting *d*² a housing for the spring *d*³. This serves several purposes. It insures that a broken valve stem does not get loose and into the crank case where it might get under the cranks and damage the case. Also that the spring *d*³ is housed from the larger part of the volume of the charge and so is not exposed to heat if this charge should by chance take fire while in the crank box and rush out past the spring while hot and burning. Such exposure would heat and destroy the temper of the spring.

In order that the fresh charge may not mix with the old charge excessively, I provide a nozzle *d*⁴ to the piston and direct the charge up toward the center of the cylinder head in a round stream of small circumference and cross area and consequent rapid speed. The opening of the nozzle *d*⁴ is less than the diameter of the valve *c* so if the valve should break from its stem or mounting *d*² it could not get out into the cylinder proper and be the cause of damage. The nozzle *d*⁴ is also preferably small so that it may not expose a large area to the burning charge when ignited and it is made a part of the piston so that the heat may be carried by the continuous metal down to the walls of the piston and there be cooled by

contact with the cool walls of the cylinder. The cylinder head e' is made spheroidal, somewhat elongated, so as to provide room for the nozzle and so as to best mass the stream of new charge and retain it in the cylinder head instead of letting it pass down the walls and out the exhaust ports $f f$. In the more common constructions wherein the new charge is admitted by a port uncovered by the piston shortly after the exhaust ports are opened, the new charge is turned up one side of the cylinder with the result that it does not mass in the head but largely by its inertia rushes over the top and down and out the other side with the exhaust. This is specially true of engines having hemi-spheric heads; yet it is well known that the hemi-spheric shape of head offers least wall surface to absorb heat.

In the more common construction the ports must extend well around the cylinder circumference in order to get the new charge in and the old charge out quickly and even under most favorable conditions, authorities on two-cycle automobile engines assert that the exhaust ports should be uncovered nearly 60° before dead center. Such uncovering results in a waste of power and a noisy exhaust. I, by extending the exhaust ports all around the cylinder with such bridges as are necessary for strength and to hold the rings in place to the piston, can run at high speed with exhaust ports which uncover but 35° to 40° ahead of dead center, about half the usual distance from dead center. This adds to the power and economy of the engine but does not materially lessen the time for admission due to the fact that the valve c in the piston is very large and so can let the transfer be made quickly and also that it can open just as soon as the pressure is off of it and remain open till the exhaust port is closed and the pressure on the working side of the valve as great as that on the crank box side. This method of admission prevents any possibility of rush of burning gases back into the crank box and insures that the old charge is expanded and cooled by this expansion below the burning point before the new is admitted by the opening of the valve, irrespective of the engine speed. It is also readily seen that in high speed engines of the more common type, the short space between the two ports offers a ready passage for gases under compression in the crank box to pass around the piston parallel to the usual piston rings and escape into the exhaust passage, or when there is vacuum in the crank box, for the burned gases in the exhaust pipes to be sucked back into the crank box to a greater or less extent. In engines which are run quite cool the oil will largely pack this space but in automobile and aeronautic work where cooling water is not readily had, the oil gets very hot and

thin and so does not offer much hindrance to the passage of gas in either direction as stated. This is particularly true in air cooled engines where pistons are made considerably smaller than the cylinder bore to allow for expansion.

I show in Fig. 1 the construction of piston which consists of the shell of which the nozzle d^4 forms part, the head d and the valve mounting d^2 which also serves as a stand for the piston pin bearing $g g$. The said bearings $g g$, the mounting d^2 and the head d are all held in place by studs $h h$ fastened to the piston proper and having nuts $i i$ on their ends to bind the bearings and all parts together. By this construction, the piston-pin bearings never get hot for they have very little connection with hot parts and are cooled by the rush of the new charge by them on its way to the cylinder proper. The valve action I have described prevents the fresh gas from being exposed to the old till the pressure of the old has passed away on which account there is very little likelihood that there will be backfiring into the crank case but to prevent this even in case the valve spring d^3 should break, I insert a screen of woven wire c' between the piston head d and the valve mounting d^2 . This has a very large area and so offers very little resistance to the passage of the gases. It is not likely to clog easily and if clogged can be removed and cleaned easily, when the piston is out of the engine. One of the requirements of an automobile engine is that it be flexible. That is, it must be capable of running at low speeds and under the action of a throttle as does a steam engine. In the common two cycle engine throttling results in less admission of mixture from the crank case and as a result of this more of the old gases are held in the cylinder. This dilutes the new charge very much and makes the engine likely to miss fire through failure to ignite the little new charge that was admitted. My construction causes the little new charge admitted to pass into and through the nozzle d^4 washing out the old ahead of it and remaining in the nozzle quite fully. I then provide a spark for ignition in the nozzle and thus make sure that the fresh charge however small will ignite because it is undiluted or not largely diluted. Further by igniting the charge farthest from the exhaust ports I insure that this gas is most fully burned when the exhaust opens and is therefore most sure to be not burning when the fresh charge enters, thus again insuring that at high speeds the engine will not fail to function properly or "backfire."

I show in Fig. 1 a form of make and break sparkler which is suited to my use. This consists of a plug k screwed or fastened into the cylinder in any well known manner. The end of this plug k has a

pivoted movable electrode *l* attached thereto and of such shape that motion of the piston against its shorter end will lift the longer end away from the insulated electrode *m*.

5 These contact ends stand slightly out of the center line of the plug and this permits the insulated electrode *m* to be eccentric at its end and be adjusted for wear or time by slightly twisting it. The movable electrode
10 *l* has a push rod *n* bearing against the outer surface of its short arm, and far out from the plug body is a spring *o* which keeps the two points in contact. The location of this spring *o* keeps it from the heat far enough
15 to insure its temper remaining intact. It is evident that if the end of the piston nozzle *d*⁴ contacts with the short arm of the electrode *l* it will separate the contact points and cause an electric arc if current is flowing
20 at the time of the separation. But it is well known that for high speed the spark should occur some time in advance of the need of power so as to give the explosive mixture time to burn. This spark advance
25 is usually gotten by some manually controlled device but, especially in aeronautic work, it is essential that as few controlling devices as possible be present. I therefore fit to the nozzle *d*⁴ a loose bar *d*⁵ headed at
30 each end and sliding in a guide hole provided therefor in the structure of the nozzle *d*⁴. The bar *d*⁵ is longer than the guide hole and will move lengthwise the pistons so far as this excess length will permit at
35 each piston stroke if the piston is moving fast. If the piston is moving slowly, as when turning the engine over by hand, the bar *d*⁵ will simply move with it and will break the sparker circuit when the piston
40 is almost at the proper dead center. This will be too near the dead center for the engine to reverse its direction or "back-kick." But when the piston is moving fast, rapidly
45 accelerating its motion to the center of its stroke and as rapidly retarding to the end of the stroke the bar *d*⁵ will accelerate with the piston but being longer than its guide and therefore free to move with relation to the piston will not retard with the piston
50 but will throw forward to the limit of its movement and arrive in contact with the arm of the electrode *l* sooner than if not thrown forward. It will therefore make the spark sooner and give the advanced
55 spark position desired. Instead of a loose bar, other forms of the loose mass may be employed. This method of advance is not a variable method because up to certain speeds it does not advance, then its advance
60 will be uncertain till still higher speeds are reached when it will be found positive in action. By some experiment the proper amount of advance for best average high speeds can be found and the spark position
65 fixed at that point. Practice seems to indi-

cate that this proper advance is about $\frac{1}{4}$ inch of piston movement in an engine having a piston stroke of $4\frac{1}{2}$ inches. But the quality of the mixture and the size of the spark seem to have some effect on this position. The large spark does not seem to require so great an advance and the power seems to be greater with the large spark. I therefore prefer to supply this plug with electricity from some source of energy which
70 is not scanty or unreliable, particularly at high speeds.

One end of the wire *w* may be grounded on the engine and the other carried to the plug in a single cylinder engine or in the
80 two cylinder engine most used by me, both wires go to their respective plugs. I lubricate these engines by feeding cylinder oil with the fuel in proportions of about one to two pints to each five gallons of fuel, and
85 this not only gets rid of the complications of oilers but feeds oil proportionate to the power and the oil keeps the leather joints from getting hard.

It will be seen that my design not only
90 insures charges of like quality and of large size but that it transfers these charges in the most direct manner to the extreme head of the cylinder cooling the piston, the spark
95 plug and the cylinder head and passing through the old charge with the least presentation of surface to the old charge and forcing the old charge out the exhaust ports
100 most evenly. Further my location of and size of spark insures firing even the smallest charges and firing that part of the charge near the valve early so it may be
105 burned and extinguished before the next charge enters. The spring tension on the valve *c* holds it against rising except when there is sufficient pressure under it to insure
110 a flow of new charge faster than the usual rate of flame propagation and thus insures freedom from back firing with lean mixtures even if the screen *c'* were absent. My
115 oiling method insures perfect lubrication of the various parts without complexity and loss of power and proportionate to the power being produced. The late opening exhaust ports give increased power and
120 quick escape of the gases as well as even distribution of the heat of the exhaust.

While I have given my preferred method of accomplishing the objects set forth modifications thereof may be used without departing from the spirit of the invention.

To get the valve *c* in place, the mounting
125 *d*² is usually made in two parts. The head *d* is shown of disk shape but may be coned and fitted to a coned seat for easy removal.

I have described this engine cylinder and the piston therefor as machined inside and out but without specially calling attention to this feature of the design. Such method of making them insures concentricity and
130

that expansion under the heat of hard work does not distort them as would likely be the case if they were not concentric and even walled around.

5 I have found by experiment that if the exhaust opening is not provided on all sides the old charge goes to the open side and is followed by the new with resultant dead
10 space opposite the port. I can therefore place the nozzle of the piston eccentrically and the sparker likewise and thus lessen this dead space but the work of machining is greater in this event and it is only warranted when it is not convenient to cut the ex-
15 haust port all around (excepting the necessary bridges for strength, of course). I have shown the piston pin as supported in bearings held by the studs but it will be evident that the more common construction wherein
20 the pin is fixed to the studs and the bearings are in the rod end, will serve just as well. I do not attach the pin to the walls of the piston because when the piston expands under heat the pin does not and this distorts the piston. The shape of the nozzle has
25 much to do with the results attained. The outer surface makes an easy line for the flow of the exhaust gases and presents no corners to get overhot. The base has much metal in
30 it and large connecting area with the walls of the piston so it draws the heat away from the point rapidly. The point is convergent so as to throw the new charge into a small round rapidly moving stream and to be
35 cooled by it. If made divergent the point does not properly cool.

I claim—

1. In a high speed gas engine, a piston having a head and an integral nozzle above
40 said head and a valve mounting within the piston and removable from beneath the head, said valve mounting being independent of the nozzle.

2. In a high speed gas engine, a piston
45 having an integral nozzle, a head, and a valve mounting and valve beneath the head,

said mounting being independent of the nozzle and mounted within the head and removable in a direction away from the nozzle.

3. In a high speed gas engine, a piston 50 having an integral nozzle, a valve head of greater diameter than the nozzle, a valve mounting and a valve located beneath the head and removable by movement in a direction away from the nozzle. 55

4. In a high speed gas engine, a piston having an integral nozzle above its head, the head being of greater diameter than the nozzle outlet, a valve mounting, a valve and means detachably supporting said valve and
60 valve mounting beneath the head and permitting of removal thereof in a direction away from the nozzle.

5. In a high speed gas engine, a piston embodying a shell, a nozzle rigid with the
65 shell, a head detachable from the shell and a valve and valve mounting removable from the shell in a direction away from the nozzle, said valve being located beneath the head and removable by movement in a direction
70 away from the nozzle.

6. In a high speed gas engine, a piston embodying a shell and a nozzle integral therewith, a detachable head within the shell, means detachably connecting said head
75 and shell, piston-pin bearings supported upon said means, and a valve mounting also supported by said means.

7. In a high speed gas engine, a piston shell having integral nozzle, studs mounted
80 in said nozzle, a piston head, a valve mounting, a valve within the nozzle of greater diameter than the nozzle outlet and piston-pin bearings supported by said studs, with means for detachably uniting said bearings,
85 mounting and head.

Signed by me at Reading, Penna., this 15th day of April 1910.

CHARLES E. DURYEA.

Witnesses:

RHEA E. DURYEA,
D. M. STEWART.