A. W. NICHOLS.

INTERNAL COMBUSTION ENGINE.

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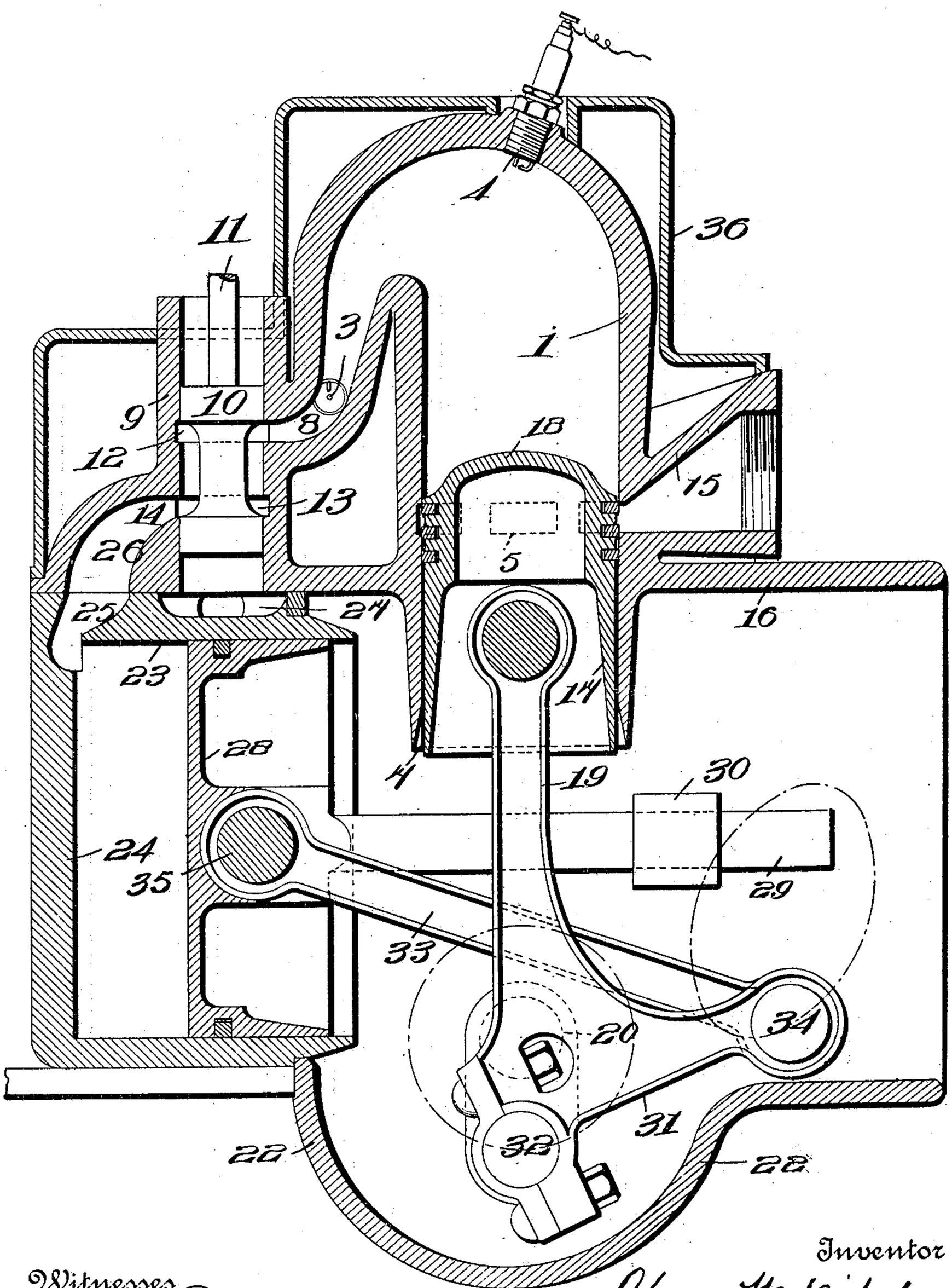
956,405. **Patented Apr. 26, 1910.**



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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

956,405. Specification of Letters Patent. Patented Apr. 26, 1910.

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To all whom it may concern:

Be it known that I, ABNER W. NICHOLS, a citizen of the United States, residing at Augusta, in the county of Kennebec and State of Maine, have invented certain new and useful Improvements in Internal-Combustion Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in internal combustion engines, and the object of my invention is to produce a simple engine, very compact, and one that will develop great power compared with its size.

With this object in view, my invention consists in the construction and combinations of parts as hereinafter described and claimed.

In the accompanying drawing, the figure is a vertical section of my improved engine.

1 represents the explosion cylinder, provided with two sparking plugs 3 and 4. This cylinder is provided with a series of exhaust ports 5, extending entirely around the cylinder. The lower end of the cylinder is open and is provided with a slit 7 to afford space for the working of the pivoted piston rod. The cylinder 1 is provided with a port 8, located near the sparking plug 3.

9 represents a valve casing in which is mounted an ordinary spool valve 10, operated in any desired way by the valve rod 11. The valve casing is open at the top and bottom, as shown, and opposite the inlet 8 is an enlargement 12, a similar enlargement 13 being provided, which is located opposite the port 14, through which the carbureted air is forced into the valve cylinder. The cylinder, valve casing, and casing 15 surrounding the exhaust ports, as well as the top 16 of the crank chamber, are all preferably made of one casting, suitably bored out and channeled.

17 represents the piston, the lower end of which is open, and having its upper end preferably curved, as shown at 18. This piston is of course provided with the usual packing rings.

19 represents a connecting rod, connecting the piston with the main shaft 20, said connecting rod being pivoted to the shaft on a pin 32. This crank shaft is mounted in the usual manner in a crank casing 22 of the ordinary shape.

On one side of the crank chamber is located the charging cylinder 23, which is preferably cast integral with said chamber. One end of this cylinder projects into the crank casing and the outer end is closed as shown at 24. At the end the cylinder is provided with a passage 25, which communicates with a passage 26 in the valve casing 9 and with the port 14 in said valve casing. Between the valve casing and the top of the cylinder 23 is a space 27, through which carbureted air is admitted, a carbureter, not shown, being attached to the casing opposite this space 27.

Within the cylinder 23 is mounted a piston 28, adapted to slide freely therein, and preferably having one end open, as shown in the drawing. To this piston is rigidly attached a piston rod 29, the other end of which passes through a hollow guide 30, mounted in the crank chamber. Two of these guides may be employed.

The connecting rod 19 is enlarged at its lower end, forming an approximately triangular extension 31, and at 32 is pivotally connected to a cranked portion of the main shaft 20.

To one end of the extension 31 is pivotally connected an arm or connecting rod 33 by the pivot 34. The other end of this arm is connected to the piston 28 by a pivot 35. Two of these arms or connecting rods 33 are preferably used, one on each side of the connecting rod 19.

It should be noted, and this is an important feature of my invention, that the pivots 34 and 35 are on opposite sides of the main crank shaft 20. This is important because it enables me to place the cylinder 23 close in to the explosion cylinder, so that the crank casing is practically no larger than the ordinary crank casing. Furthermore, a very much longer stroke may be given to the piston 28, so that the cylinder 23 may be made of comparatively small diameter. This is an important advantage because it enables me to make the parts much lighter

to resist the strain incident to back firing, which often occurs in the best engines, and enables me to produce a very compact structure. Another important point is that by means of the construction described a perfect timing can be obtained. The pivot 34 travels in an elliptical path, shown in dotted lines in the figure. During the greater part of the stroke of the explosion piston 17, the compression piston 28 moves but a very small distance, say about one-sixteenth of its full stroke, and in fact for about half the distance traveled by the pivot pin 34, the piston 28 has only a very small travel. By proportioning the parts in this way, accurate and thorough scavenging and such timing as results in firing a charge of perfectly clean gas in amount equal to three times the cubic displacement of the firing piston is secured, as will be pointed out in the description of the operation.

The explosion cylinder 1 and the parts connected thereto are provided with the common water jacket 36. It is not necessary to cool the cylinder 23. The construction of the crank casing, connections for operating the timing plugs, etc., are of the usual type, except as hereinbefore described.

The operation is as follows:—An explosion having just occurred in the cylinder 1, the piston 17 is descending. Just as it uncovers the exhaust ports 5, the piston 28 forces a charge of uncompressed carbureted air through the passages 25, 26, 14 and 8 into the top of the cylinder 1. It should be noted that the inlet for the carbureted air is directed into the top of the cylinder 1, and that the parts are curved so as to prevent eddying of the fresh charge which is being forced in by the piston 28, thus insuring a thorough scavenging of the cylinder 1, especially because the exhaust ports 5 are of such an area that there is an abundant space for the escape of the burned gases. It is also to be noted that the fresh charge just previous to ignition is disposed almost wholly within the passage between the valve 10 and cylinder 1, and that at the time of ignition the space between the top of piston 18 and the top of cylinder 1 is very small, that is, just enough for clearance. This saves a few inches in the height of the finished machine.

After the piston 17 has opened the ports 5, the pivot 34 is nearly at its lowest point. The motion of the pivot 34 is then forward and upward, and this imparts a very rapid reciprocating motion to the piston 28, forcing the fresh, uncompressed charge into the top of the cylinder 1, and owing to the shape of the cylinder and the connecting passages, this fresh charge comes against the burned gases and forces them out through the open ports 5, thoroughly scavenging the engine. The size of the cylinders 1 and 23 and the passages connecting them is so proportioned that such a charge has been forced in and scavenged the cylinder 1 just as the exhaust ports 5 are closed on the upward motion of the piston 17. The piston 28, however, still continues to advance, forcing in an additional amount of carbureted air into the cylinder 1 and the passages connected therewith while the piston 17 is rising, thus causing a compression in the upper part of the cylinder 1 and the passages connected therewith. From actual experiment, I have found that the capacity of the cylinder 23 should be, to produce the best results, three times the cubic capacity of that part of the cylinder 1 through which the piston 17 travels. The piston 28 is arranged so that it will have delivered approximately two-thirds of the carbureted air in the cylinder 23 into the cylinder 1 when the ports 5 are closed. Then the additional one-third is forced into the cylinder 1 and the passages communicating therewith during the upward movement of the piston 17. The complete charge of carbureted air is forced into the cylinder 1 at about the time the piston 17 is half way up on its upward stroke. A further upward movement of the piston 17 compresses the charge in the cylinder 1 and the passages communicating therewith, the valve 10 being meantime shifted so as to prevent back flow of the gas into the passage 6.

When the piston 17 has nearly reached the top of the cylinder 1, the spark plugs 3 and 4 are fired, preferably simultaneously, or the spark plug 3 may be fired just a little sooner than the spark plug 4, this firing being effected by any well known devices. The result is that the gas in the passages 2 and valve cylinder 9 is first fired and the firing then takes place at the top of the cylinder 1, forcing the piston 17 down. It is of importance that the gases in the passages 8 should be fired first, so that there will be no danger of back firing when the fresh charge of carbureted air is forced into the cylinder 1. On explosion the piston 17 is forced downward until it uncovers the ports 5, the piston 28 being drawn backward in the meantime and sucking in a fresh charge of carbureted air. After this, the operation is continued indefinitely.

The purpose of my invention is to improve that class of internal combustion engines in which is employed a charging pump (or piston and cylinder) in combination with a working (or firing) piston and cylinder.

My invention is an improvement on this class of engines in that the following results are obtained: (1) Cheapening and simplifying the construction of the charging pump and economizing the space occupied by the engine. (2) Reducing the total weight and cost of the engine. (3) Largely increasing the power of an engine of a given size and

weight, by firing a charge of about three times the usual amount, and (4) transferring the charge from the charging cylinder to the explosion cylinder without precompression.

It should be noted that in order to provide compactness and render possible the making of the parts light in proportion to the power developed by the engine, that I have located the charging pump within the main casing on one side and operate the piston therein by means of a connecting rod or rods of considerable length, these rods being pivoted at one end to the charging piston and extending across and to the other side of the main shaft and across the connecting rod which connects the explosion piston with a crank on the main shaft. By this means, I am enabled to time the operation of the engine exactly, to make the compression cylinder compact and of small size, and to provide a connecting rod of sufficient length so that the operation of the charging piston will be exactly timed in relation to the movement of the piston in the explosion cylinder.

It should be noted that the pivot 34 on the connecting rod 19 is on the opposite side of said connecting rod to that occupied by the charging cylinder. This permits the employment of a long connecting rod 33 between said pivot and the charging piston, and also allows the charging cylinder to be located close to the crank shaft, well within the usual limits of a crank case, and avoids the necessity of unduly increasing the diameter of said charging cylinder and at the same time shortening the stroke of the piston therein. This is especially important when it is considered that the charging pump must be constructed strong enough in all its parts to withstand back firing, and that if its diameter is unduly large the entire construction, including the connecting rods, must be correspondingly heavier and must occupy more space. Furthermore, as already noted, this construction renders an accurate timing of the charging pump possible, and renders it possible to so proportion the charging pump in its various dimensions that without any precompression the firing cylinder is completely scavenged and a supplementary charge is later introduced into the firing cylinder, so that at the time of firing the charge consists (if uncompressed) of about three times the cubical contents of the space in the firing cylinder through which the piston moves.

The peculiar timing in this engine permits of the employment of a charging pump without excessive clearance at the end of the stroke, which renders it possible to use a much more compact construction.

I claim:—

1. In an internal combustion engine, the combination of a crank casing, a main shaft having a cranked portion mounted therein, a charging cylinder in said crank casing, a piston in said cylinder, a piston rod rigidly connected to said piston and guided by a part of said crank casing, an explosion cylinder located on top of said crank casing, a valve cylinder connected to said explosion cylinder and to said charging cylinder, a valve in said last named cylinder, a piston in said explosion cylinder, a plurality of sparking plugs for said explosion cylinder, and connections between said pistons and said main shaft, including a connecting rod running from the piston in the explosion cylinder to the cranked portion of the main shaft, said connecting rod being provided with a triangular extension, and a connecting rod pivoted to said extension and to the piston in the charging cylinder, said last named connecting rod extending across and above the main shaft, whereby accurate timing is attained, substantially as described.

2. In an internal combustion engine, the combination of a crank casing provided with a guide, a cranked shaft journaled in said casing, a charging cylinder located in said casing, a piston in said charging cylinder, a piston rod rigidly connected to said piston and passing through said guide, an explosion cylinder located on top of said crank casing, a valve cylinder located on one side of said explosion cylinder and communicating with the charging cylinder and the explosion cylinder, passages being left so that a large proportion of the charge is contained in said passages, a plurality of sparking plugs, a water jacket for the explosion cylinder, a piston in said explosion cylinder, and connections between said pistons and the main shaft, including a connecting rod pivotally connected to the piston in the explosion cylinder and to the cranked portion of the main shaft, said connecting rod having near its lower end a triangular extension, and a connecting rod pivoted at one end to said extension and at the other end to the piston in the charging cylinder, said last named connecting rod extending across and above the main shaft, substantially as described.

In testimony whereof, I affix my signature, in presence of two witnesses.

ABNER W. NICHOLS.

Witnesses:
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