

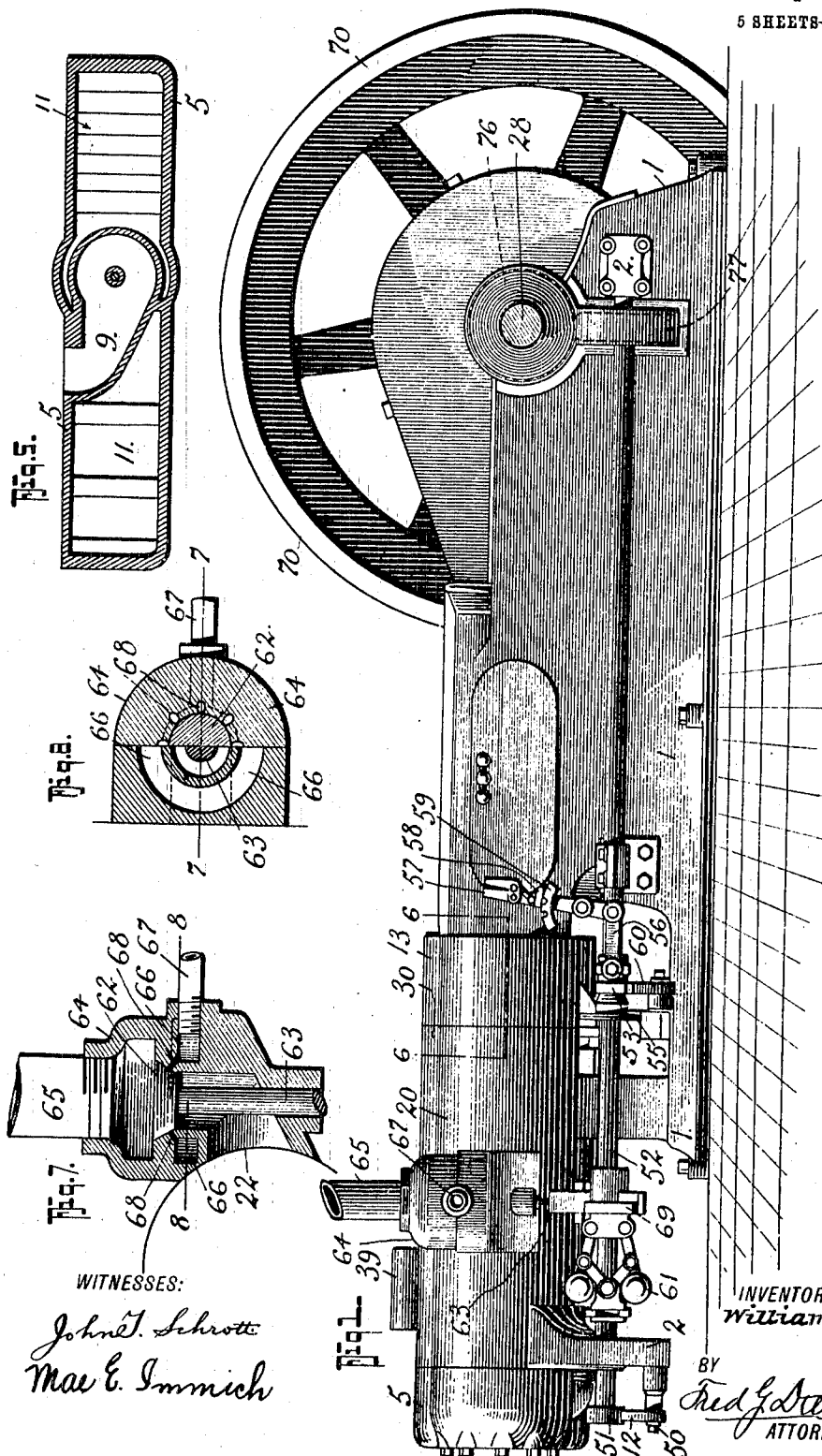
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JAN. 11, 1909. RENEWED FEB. 28, 1913.

1,059,421.

Patented Apr. 22, 1913.

5 SHEETS—SHEET 1.



WITNESSES:

John T. Schrott
Mae E. Immich

INVENTOR
William J. Wright.

BY
Frederick G. Beterndale
ATTORNEYS.

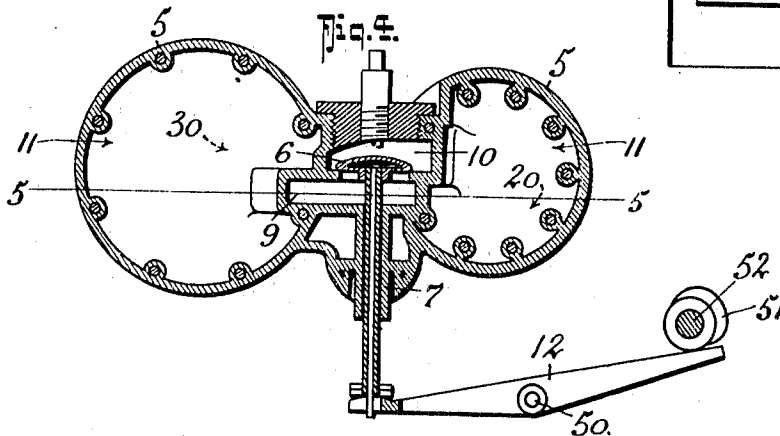
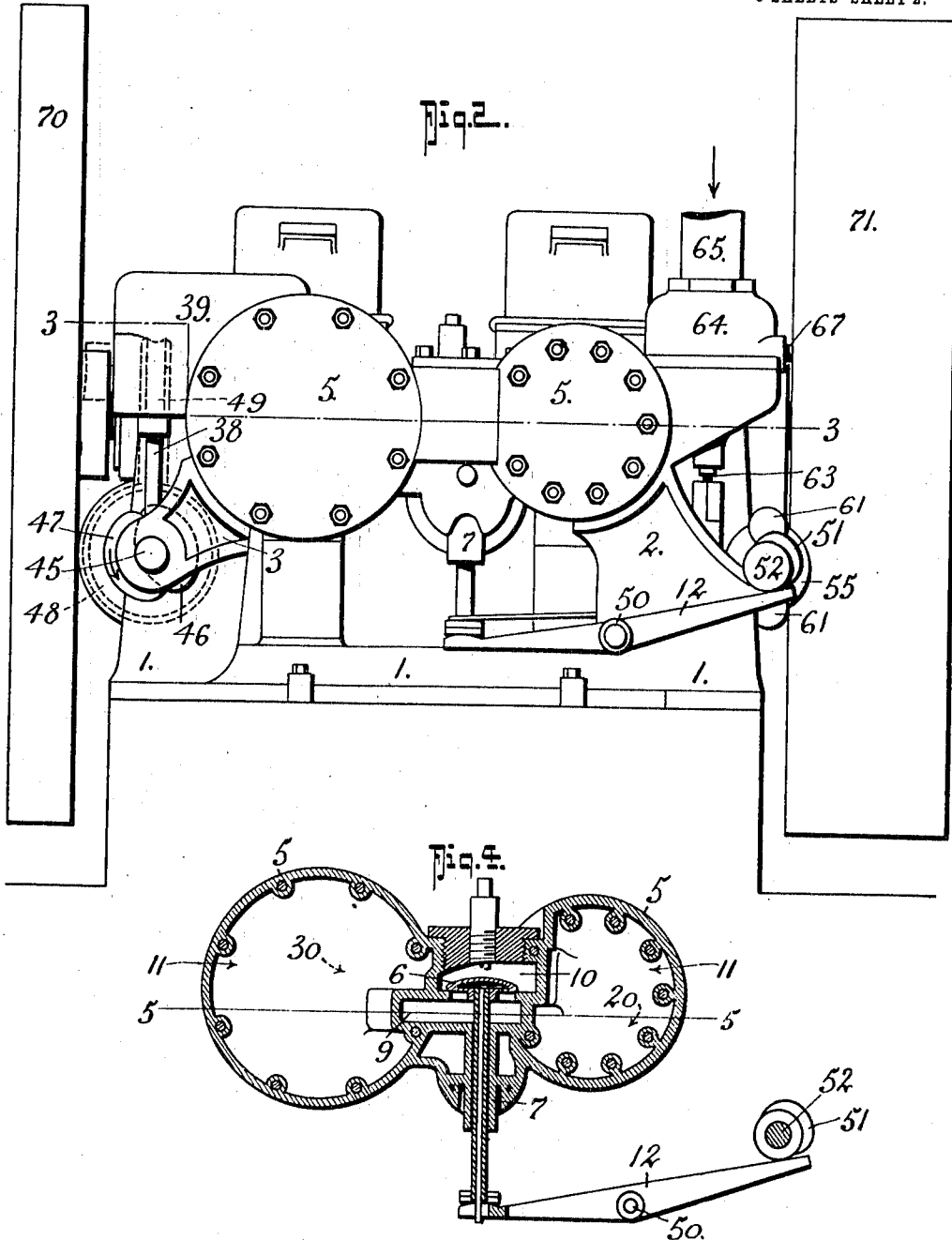
W. J. WRIGHT.
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JAN. 11, 1909. RENEWED FEB. 28, 1913.

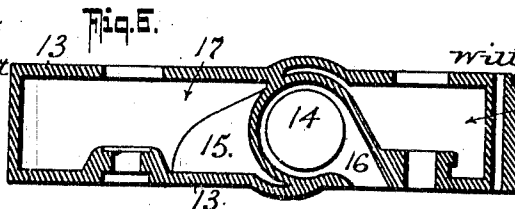
1,059,421.

Patented Apr. 22, 1913.

6 SHEETS—SHEET 2.



WITNESSES:
John T. Schrott
M. E. Immich



INVENTOR
William J. Wright.

BY
Fred G. Duteau
ATTORNEYS.

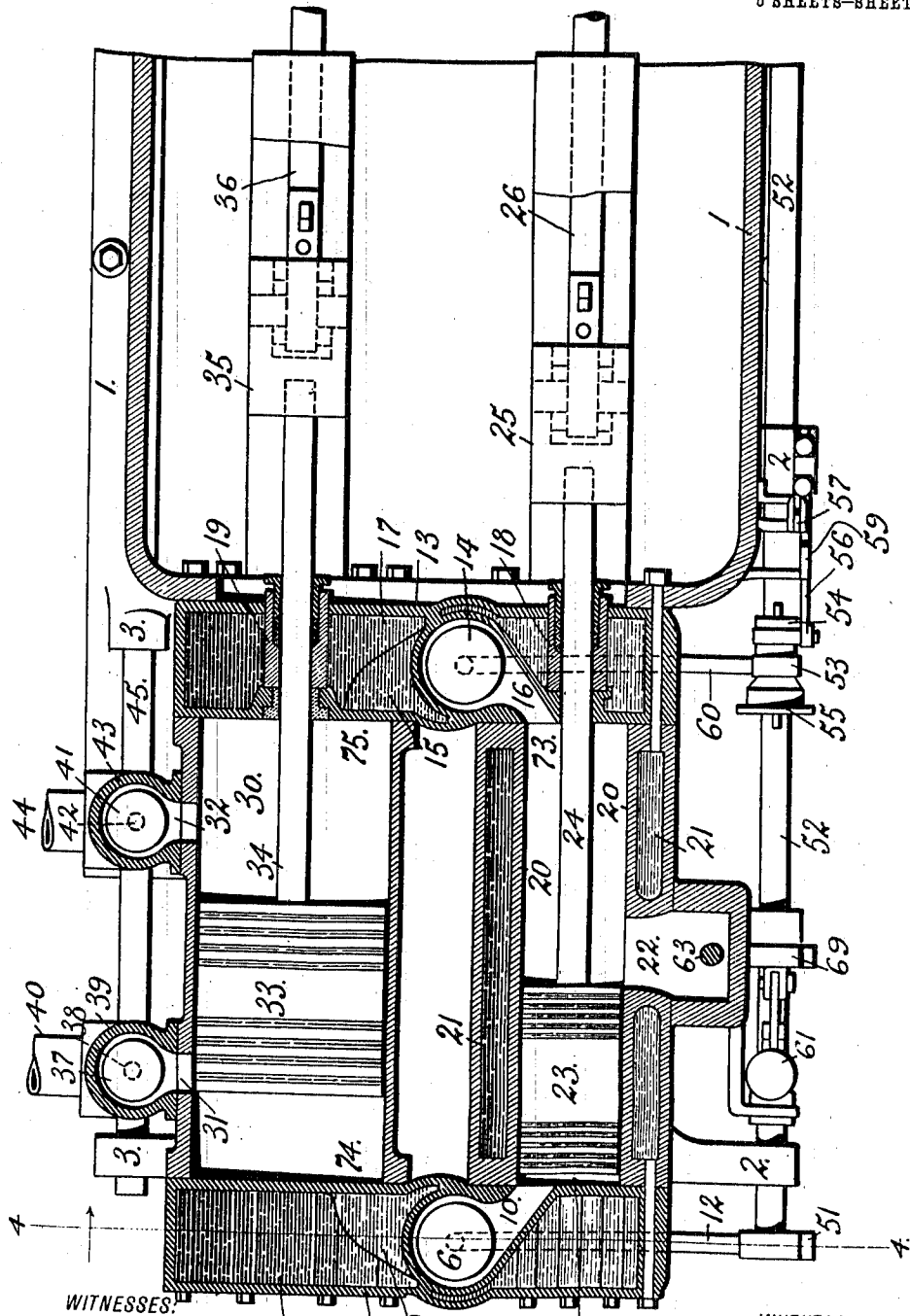
W. J. WRIGHT.
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JAN. 11, 1909. RENEWED FEB. 28, 1913.

1,059,421.

Patented Apr. 22, 1913.

6 SHEETS—SHEET 3.



WITNESSES:

John T. Schrotte
Mac E. Immich

J. T. Schrotte

INVENTOR

William J. Wright.

BY
Fred Y. Dietrich
ATTORNEYS.

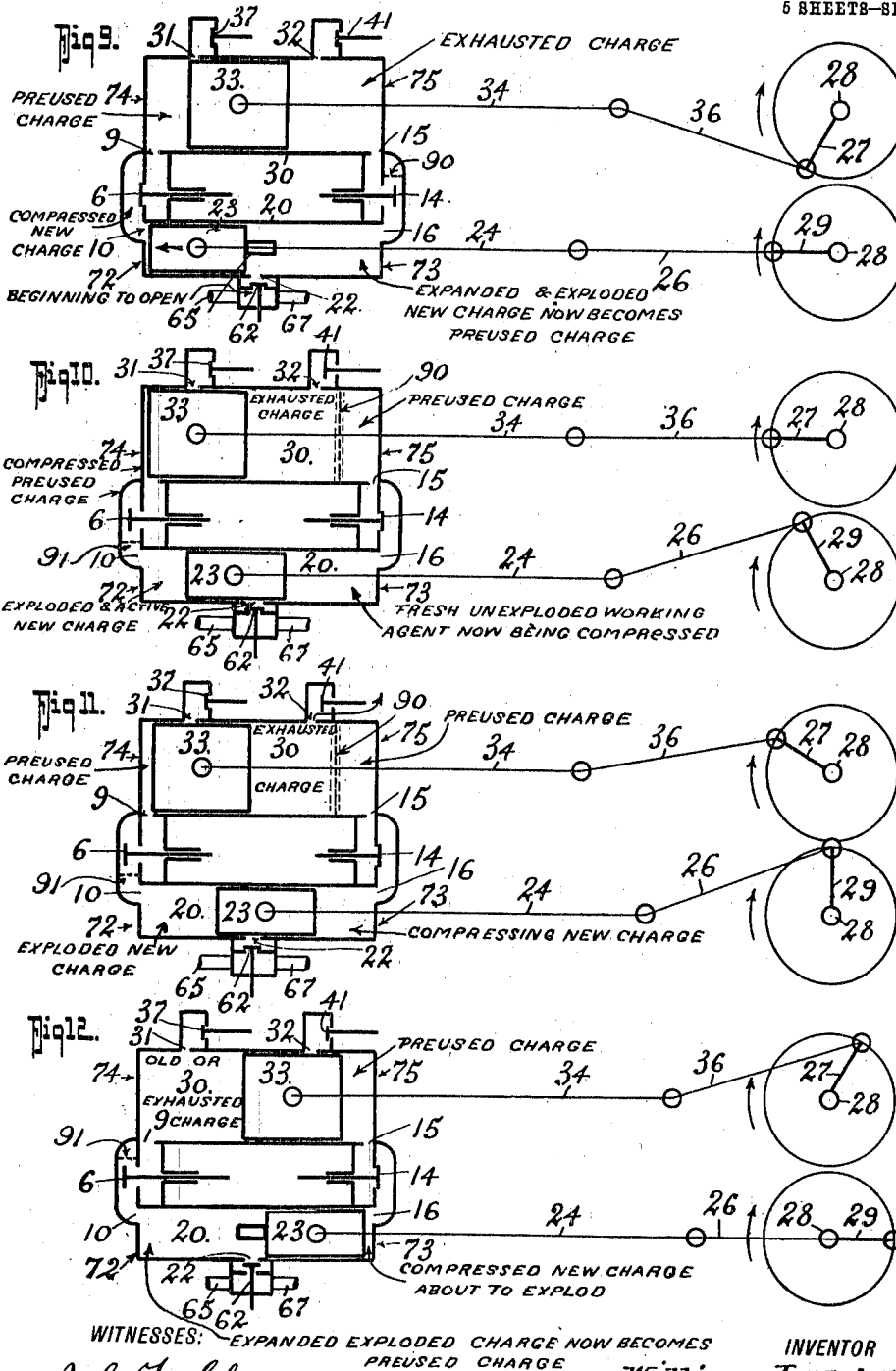
W. J. WRIGHT.
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JAN. 11, 1909. RENEWED FEB. 28, 1913.

1,059,421.

Patented Apr. 22, 1913.

5 SHEETS—SHEET 4.



John T. Schrott.
Mac E. Immich

INVENTOR
William J. Wright.

BY
Fred G. Dietrich & Co.
ATTORNEYS

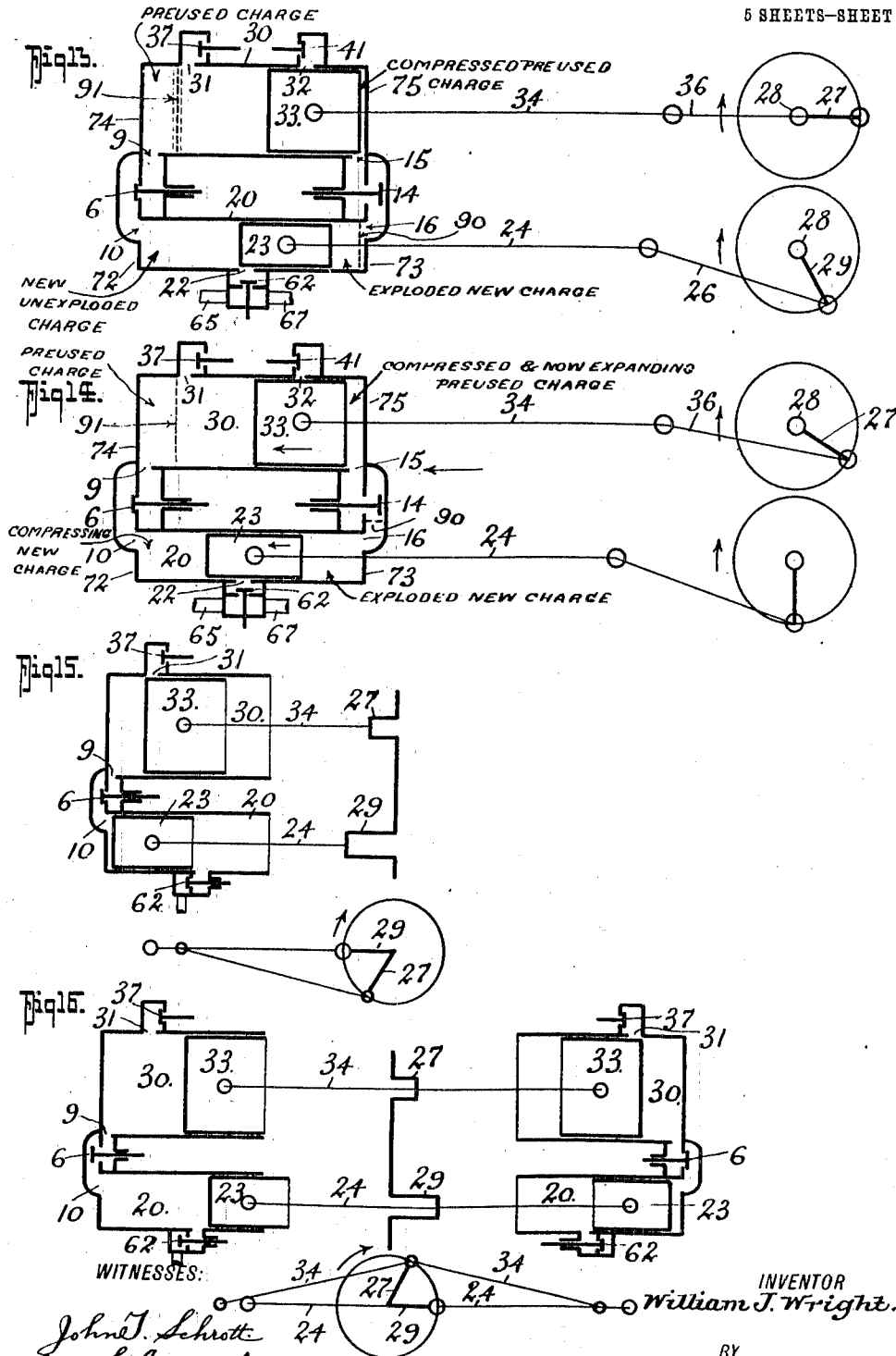
W. J. WRIGHT.
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JAN. 11, 1909. RENEWED FEB. 28, 1913.

1,059,421.

Patented Apr. 22, 1913.

5 SHEETS—SHEET 5.



WITNESSES:
John T. Schrott
Mae E. Immich

INVENTOR
William J. Wright.
BY
Fred G. Dietrich & Co.
ATTORNEYS

UNITED STATES PATENT OFFICE.

WILLIAM J. WRIGHT, OF FRANKLIN, PENNSYLVANIA.

INTERNAL-COMBUSTION ENGINE.

1,059,421.

Specification of Letters Patent.

Patented Apr. 22, 1913.

Application filed January 11, 1909, Serial No. 471,553. Renewed February 28, 1913. Serial No. 751,389.

To all whom it may concern:

Be it known that I, WILLIAM J. WRIGHT, residing at Franklin, in the county of Venango and State of Pennsylvania, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention is a high pressure, high speed, compound, two cycle engine, and in its generic nature the invention resides in an engine wherein the working agent is first exploded to exercise its force on a primary piston in a high pressure cylinder and is then withdrawn from action on such piston and re-compressed by a secondary piston in a low pressure or secondary cylinder, after which the charge is returned in whole or part to the primary cylinder to add its energy to that of a second charge in the primary cylinder that is acting on the high pressure piston, and also at the time the high and low pressure cylinders are thrown into communication to equalize the pressure in the two, whereby the combined charge of recompressed, primarily exploded working agent and the newly exploded new charge will act together on the high and low pressure pistons to cause them to move in unison and add their force together as one.

Again my invention resides in an engine having a primary or high pressure cylinder and its piston and an auxiliary, secondary or low pressure cylinder and its piston which secondary piston operates during a part of its cycle to evacuate the primary cylinder to thereby draw in a new charge of fresh working agent to the primary cylinder; during another part of its cycle the secondary piston operates to recompress the first exploded charge within the secondary cylinder which has been drawn from the primary cylinder and at a predetermined time return the recompressed exploded charge to its starting place in the primary cylinder to add its energy to that of the second new charge in the primary cylinder; during another part of its cycle the secondary piston serves to draw both the first recompressed and preused charge together with the second exploded charge into the secondary cylinder and simultaneously recharge the primary cylinder with a fresh charge of working agent; under another part of its cycle the secondary piston exhausts the first reused charge to atmosphere at atmospheric pressure.

More briefly the gist of my invention resides in a two-cycle compound engine wherein the working agent is used to act on a primary piston, after which it is recompressed by a secondary piston in the secondary cylinder and is returned to the primary cylinder to again act on the primary piston in conjunction with a freshly used new charge and simultaneously act on the secondary piston so both pistons move together during a part of their cycle of movement after which the reused charge is withdrawn from the primary cylinder into the secondary cylinder and exhausted from the secondary cylinder to atmosphere at atmospheric pressure in a practically smokeless and odorless condition and fully consumed.

Another object of my invention is to so manipulate the reuseable charge, which has been reduced to a lower temperature, in conjunction with the new charge at a high temperature, to act on the primary piston by increasing the volume of agent within the zone of action of the piston, so as to lower the temperature during a portion of the cycle of operation and continuing the stroke of the piston at such lower temperature and increased volume of working agent and thus aid in absorbing the heat from the walls of the primary working cylinder.

Another object of my invention is to provide an engine of the double acting, two-cycle, compound type embodying the construction and operation aforesaid.

My invention also resides in those novel details of construction, combination, operation and arrangement of parts, which will be first fully described in detail, then be specifically pointed out in the appended claims, reference being had to the accompanying drawings in which:

Figure 1, is a side elevation of the double acting form of my engine. Fig. 2, is an end elevation thereof. Fig. 3, is a horizontal section on the line 3—3 of Fig. 2. Fig. 4, is a cross section on the line 4—4 of Fig. 3, looking in the direction of the arrow. Fig. 5, is a horizontal section on the line 5—5 of Fig. 4. Fig. 6, is a horizontal section on the line 6—6 of Fig. 1. Fig. 7, is a detail vertical section on the line 7—7 of Fig. 8. Fig. 8, is a horizontal section on the line 8—8 of Fig. 7. Figs. 9 to 14 inclusive, are diagrammatic views hereinafter specifically referred to. Fig. 15, is a diagrammatic view of a single acting engine without a

cross-head. Fig. 16, is a double single acting engine wherein two engines of the type shown in Fig. 15 are connected to a single crank shaft and in opposite alinement.

Referring now to the accompanying drawings, in which like letters and numerals of reference indicate like parts in all of the figures, 1 designates the bed on which the primary or high pressure cylinder 20 which has a fresh working agent inlet port 22, is mounted. Within the cylinder 20 is the high pressure piston 23 that is secured to a piston rod 24 which projects through a gland 18 in the front head 13 and terminates in a cross head 25 to which the connecting rod 26 is pivoted. The rod 26 connects with the crank 29 of the drive or crank shaft 28.

The primary cylinder 20 is water-jacketed at 21. The secondary or low pressure cylinder 30 has suitably positioned exhaust ports 31—32, and is mounted on the bed 1. The heads 5 and 13 serve for both cylinders 20—30 and have water-jacket spaces 11—17 respectively. The head 5 houses the valve 6, which controls communication between the ports 9 and 10 that respectively communicate with the ends 74 and 72 of the cylinders 30 and 20, respectively. The valve 6 has its stem projected through a bearing 7 to engage the trip lever 12. The secondary or low pressure piston 33 has its rod 34 projected through a gland 19 in the head 13 and joined with a cross head 35 that connects with the crank 27 through a connecting rod 36, as shown. A valve 14 of like construction to the valve 6 controls communication between the port 15 from the end 75 of the cylinder 30 and the port 16 from the end 73 of the cylinder 20, the valve 14 having its stem arranged to be engaged by the trip lever 60. The exhaust valve 37 has a stem 38 that is disposed within a casing 39, having an outlet pipe 40 to atmosphere. The valve 37 is actuated by a cam 46 on a shaft 45 that is mounted in bearings 3—3 and driven from the crank or drive shaft 28 by gears 48 and 49. The other exhaust valve 41 is of the same construction as the valve 37 and includes the stem 42, the casing 43 and an outlet pipe 44, to atmosphere. The valve 41 is actuated by a cam 47 on the shaft 45. The lever 12 is pivoted at 50 and is engaged by a cam 51 on the shaft 52 that is mounted in bearings 2, and is driven from the crank shaft 28 by gears 76 and 77. The lever 60, for operating the valve 14 is operated by a cam 53 on a shiftable sleeve 54 that has a collar 55 and is shiftable by a lever 57 and rod 56. The lever 57 is held in its various positions by a latch 58 and rack 59. The working agent inlet valve 62 is operated by a cam 69 on the shaft 52 which engages the valve stem 63, and the action of the cam 69 on the stem 63 may be controlled by any suitable

governor device 61, indicated in Figs. 1 and 3 of the drawings. The valve 62 has a casing 64 that incloses a gas chamber 66 into which the gas pipe 67 leads and which communicates with the valve passage by ports 68, as shown in detail in Fig. 7. Air is admitted to the casing 64 through an air pipe 65. Fly wheels 70 and 71 are provided on the crank shaft 28 to overcome dead centers and for the usual purposes.

The foregoing is a general description of the construction of my engine and the valve actuating means, it being understood that the valves are set to operate at predetermined times.

Definitions of terms hereinafter used.

1st. A new charge, *i. e.*, a fresh charge of working agent that has never been exploded. 2nd. An exploded new charge, *i. e.*, the new charge after it has been first ignited or exploded. 3rd. A primary exploded or pre-used charge, *i. e.*, the exploded new charge that is to be used a second time in the high pressure cylinder to act on its piston and also to be used in the low pressure cylinder to act on the low pressure piston. 4th. The finally exploded or exhausted charge, *i. e.*, the pre-used charge after it has been used a second time and its energy finally used up and expended. 5th. A fresh charge of combustible fuel or combustible agent, *i. e.*, either gaseous or liquid fuel before it has been used in the engine. 6th. Working agent, *i. e.*, the combined combustible substance and the supporter of combustion. 7th. "An element of the working agent," *i. e.*, either the combustible substance or the supporter of combustion.

Operation of the form shown in Figs. 1 to 14.—Assume the engine to have been running for several cycles and all chambers operating and assume the parts to have reached the position shown in Fig. 9. In this position, the valves 6, 37 and 41 will be closed and the valve 62 just having closed and valve 14 being open. There will be a pre-used charge in the chamber 74 and an exhausted charge in the chamber 75 of the cylinder 30, and at the same time there will be a compressed new charge in the chamber 72 of the cylinder 20 and an expanded, exploded charge in the chamber 73, which, from this time on, becomes a pre-used charge. The exhausted charge in the chamber 75 is separated from the exploded and expanded charge in the chamber 73 (both charges being at atmospheric pressure) by the theoretical parting line 90 in Fig. 9. The compressed new charge in the chamber 72 in Fig. 9, is just about to be exploded to move the parts from the position shown in Fig. 9 to the position shown in Fig. 10. When the parts are in the position shown in Fig. 9, the valve 62 just begins to open and it then remains open until

the piston 23 closes the port 22. As the parts move from the position shown in Fig. 9 to that shown in Fig. 10, the piston 33 will cause a suction in the chamber 73 before the valve 14 closes, and before port 22 becomes closed by the piston 23, thus drawing a fresh charge of working agent into the chamber 73 during the movement from the position shown in Fig. 9 to the position shown in Fig. 10. Furthermore, as the parts arrive at the position shown in Fig. 10, the valve 6 opens and permits the compressed pre-used charge in the chamber 74 in Fig. 10 to unite its pressure and heat with that of the exploded new charge in chamber 72 in Fig. 10, and cause both pistons 23 and 33 to move together in unison. The parts are now in the position as shown in Fig. 10. A compressed pre-used charge is in the chamber 74 and part of it is in the chamber 72, it being separated from the active exploded new charge in chamber 72 by the theoretical line 91, the valve 6 being open to open communication between the chambers 74 and 72. At the same time there will be an exhausted charge and a pre-used charge in the chamber 75 separated from one another by the theoretical line 90 in Fig. 10. The valve 41 has just opened; the valve 14 is closed. While the parts are positioned as shown in Fig. 10, there will be a fresh new exploded charge of working agent undergoing compression in the chamber 73 in Fig. 10. Now as the parts move from the position shown in Fig. 10 into the position shown in Fig. 11, the pistons 23 and 33 move together. When the parts have arrived at the position shown in Fig. 11, the valves 6 and 41 will still be open and the valves 14 and 37 will still be closed, as will also be the valve 62. The pre-used charge in chamber 74 and the exploded new charge in chamber 72 are still exercising their combined force on the pistons 33 and 23. While the parts are in the position shown in Fig. 11, the old exhausted charge in the chamber 75 is being forced through the valve 41 to atmosphere. The pre-used charge in chamber 75 remains as it was in Fig. 10. The new charge in chamber 73 is still undergoing compression. Now assume the parts to have reached the position shown in Fig. 12, the old exhausted charge will fill the chamber 74. The pre-used charge in chamber 75 is being compressed. The valves 37, 41 and 14 are closed, while the valves 6 and 62 are open. The charge of exploded working agent in chamber 72 will have expanded to atmospheric pressure. The new charge in chamber 73 will have become fully compressed and about ready to explode. The piston 33 has commenced to suck in a fresh charge of working agent into the chamber 72 and to draw the exploded expanded charge from the chamber 72 into the

chamber 74. An explosion now occurs in chamber 73 in Fig. 12 and the parts move from the position shown in Fig. 12 to the position shown in Fig. 13. When the parts reach the position shown in Fig. 13, the valves 6, 41 and 62 have closed; the valves 37 and 14 have opened. At this time there will be an old exhausted charge and a pre-used charge in chamber 74 separated by the theoretical line 91, and at the same time there will be a new unexploded uncompressed charge in chamber 72 which is about to be compressed. At the same time there will be a compressed pre-used charge in the chamber 75 which is uniting its force with the exploded new charge in chamber 73, a part of the compressed pre-used charge in chamber 75 being also contained in chamber 73 in Fig. 13 and separated from the exploded new charge by the theoretical line 90, thus chambers 73 and 75 are in communication through the valve 14 and there are equal pressures in both chambers which serve to make both pistons 23 and 33 move in unison from right to left in Fig. 13, as they leave the position shown in Fig. 13 to go to the position shown in Fig. 14. In moving from the position shown in Fig. 13 to the position shown in Fig. 14, the new charge in chamber 72 is being compressed by the piston 23, the exhausted charge in chamber 74 is passing to atmosphere through the valve 37. The equalized pressures in chambers 75 and 73 are forcing the pistons 23—33 in the direction of the arrows in Fig. 14. As the parts move from the position shown in Fig. 14 back to the position shown in Fig. 9, the cycle of operation is complete and further movements of the parts merely repeat the foregoing operations. By manipulating the lever 57 to bring the collar 55 into engagement with the lever 60, the valve 14 may be held opened at all times, so as to throw the cylinder ends 73 and 75 out of operative action so that the engine can work as a single acting two-cycle compound engine.

In Fig. 15, I have diagrammatically illustrated a modification of my invention wherein the engine is a single acting two-cycle compound engine without the use of a cross-head. In Fig. 16, is shown the same engine shown in Fig. 15, used as a double opposed engine, using a common crank shaft and cranks. The operation of the engine disclosed diagrammatically in Figs. 15 and 16, is precisely the same so far as the cylinder ends 74, 72, 73 and 75 are concerned, and the operation of the forms shown in Figs. 15 and 16 will be readily apparent to those skilled in the art to which the invention appertains, by reference to the operation of the forms shown diagrammatically in Figs. 9 to 14 inclusive.

Attention is called to the fact that the

valves 6 and 14 are not opened to admit the cooler compressed pre-used charge from the cylinder 30 into the cylinder 20 to unite with the new charge therein until such new charge
 5 has been compressed by the piston 23 and burned, in other words, the pre-used charge is not added to the new charge in the cylinder 20 until after such new charge has been
 10 fired to force the piston 23 on its working stroke. Therefor fouling of the new unexploded charge is prevented and the full initial force of the fired new charge is utilized.

From the foregoing description taken in
 15 connection with the accompanying drawings, it is thought the complete construction, operation and advantages of my invention will be readily understood by those skilled in the art to which the invention appertains. I
 20 desire to say, however, that I do not wish to limit myself to the exact construction and mechanical features of my engine, as disclosed in the drawings and described herein as numerous changes in the mechanical construction of the engine can be made without
 25 departing from the gist of my invention, which, as before stated, resides in any engine wherein the working agent charge is first exploded and its energy expended on a
 30 piston, after which it is removed and replaced by a new charge, which in turn is exploded and to which the formerly used charge is added to be used over again, a second time, after which, the first exploded
 35 charge, which then becomes the old exhausted charge plus the second charge that was exploded is withdraw from the first or primary cylinder, replaced by a third new
 40 charge, the second charge being then the reusable or pre-used charge after which the old exploded or exhausted charge is removed to atmosphere while the second charge in whole or in part is returned to the third new
 45 charge after it has been exploded and so on *ad infinitum*, in other words, my invention resides in an engine of the type stated in which the exploded charge is used over again, in whole or in part, by adding to it a fresh charge, before exhausting to atmosphere.
 50

What I claim is:—

1. In a two-cycle engine, a primary cylinder and its working piston and a secondary cylinder and its working piston, a crank
 55 shaft and connecting rods between said crank shaft and said pistons, said crank shaft having a crank portion for each connecting rod, one of said crank portions being set in advance of the other to cause said
 60 pistons to move in definite relation to one another, a valved exhaust port for said secondary cylinder, a valved intercommunicating port between said primary and secondary cylinders, and a valved inlet port to said
 65 primary cylinder combined with valve actu-

ating means for actuating said valves at predetermined times to cause said secondary piston to act as a pump piston during a part of its cycle of operation to draw a new charge into said primary cylinder and simultaneously remove an exploded new
 70 charge from said primary cylinder into said secondary cylinder during a part of the cycle of movement of said pistons and to cause said piston to force an exhausted
 75 charge through said exhaust port to atmosphere during another part of its cycle of movement and to cause said secondary piston to return a pre-used charge to said primary cylinder to unite with an exploded
 80 new charge in said primary cylinder during another part of the cycle of movement of said pistons, all of said operations taking part in a predetermined order.

2. In a two-cycle engine, a primary cylinder and its working piston, a secondary cylinder and its working piston, a crank shaft and connecting rods between said crank shaft and said pistons, said crank shaft having its cranks set to cause said pistons to
 85 operate one in advance of the other, port connections between said cylinders, a new charge inlet port to said primary cylinder and an exhausted charge outlet port for said secondary cylinder, combined with valve devices for controlling said ports and means
 90 for operating said valve devices through predetermined cycles of operation to cause said secondary piston to act as a pump piston for supplying a charge to said primary cylinder during one part of its cycle of operation, and to act as a working piston during
 95 a further part of its cycle of operation and to act as an exhaust discharging piston during a still further part of its cycle of operation.
 100

3. In a two-cycle engine, a primary cylinder and its working piston, and a secondary cylinder and its piston, a new charge inlet port for said primary cylinder, an exhaust
 110 port for said secondary cylinder and an intercommunicating port between said cylinders, a crank shaft, connections between said crank shaft and said pistons to cooperatively move said pistons one in advance of
 115 the other together with means cooperating with the aforesaid parts for controlling said ports to cause said secondary piston to act as a suction pump piston during one part of its cycle of operation to supply fuel to
 120 the primary cylinder and to act with the primary piston as a working piston during a second part of its cycle of operation, and to act as an exhaust discharging piston during a third part of its cycle of movement,
 125 and to return a predetermined pre-used charge from the secondary cylinder to the primary cylinder during a fourth valve part of its cycle of movement.

4. In an engine of the character stated, a 130

primary cylinder and its working piston, a secondary cylinder and its piston, a crank shaft, connecting rods between said pistons and said crank shaft, said crank shaft having its cranks set to cause said pistons to move one in advance of the other, port connections between said cylinders, means cooperating with the aforesaid parts to cause the secondary piston to act as a suction pump piston during one part of its cycle of operation to supply fuel to the primary cylinder, and to act as a force pump piston during a further part of its cycle of operation to inject a pre-used charge into the primary cylinder.

5. In an engine of the character stated, a primary cylinder and its working piston, a secondary cylinder and its piston, a crank shaft, connecting rods between said pistons and said crank shaft, said crank shaft having its cranks set to cause said pistons to move one in advance of the other, port connections between said cylinders, means cooperating with the aforesaid parts to cause the secondary piston to act as a suction pump piston during one part of its cycle of operation to supply fuel to the primary cylinder, and to act as a force pump piston during a further part of its cycle of operation to inject a pre-used charge into the primary cylinder, and to act as a working piston during a still further part of its cycle of operation.

6. In an engine of the character stated, a primary and a secondary cylinder, a piston for each of said cylinders, a crank shaft having cranks set at an angle to one another, connecting rods between said pistons and cranks, port connections between said cylinders, an inlet port to the primary cylinder, and an exhaust port to the secondary cylinder, valve devices for said ports, and means for actuating said valve devices to cooperate with said pistons to cause said secondary piston to act as a suction pump piston during one part of its cycle of operation to supply fuel to the primary cylinder, and to act as a force pump piston to inject a pre-used charge into the primary cylinder during a second part of its cycle of operation, and to act as a working piston during a third part of its cycle of operation, and to act as an exhausting piston during a fourth part of its cycle of operation.

7. In a two-cycle engine, a primary cylinder and its working piston, and a secondary cylinder and its working piston, a new charge inlet port to one of said cylinders and an exhaust port for the other cylinder, a crank shaft and connections between said crank shaft and said pistons, said crank shaft having its crank set to cause said pistons to operate one in advance of the other, valves for said ports, and a valve controlled port connection between said cylinders, to-

gether with mechanically actuated devices for operating said valves at predetermined intervals to cause said secondary piston to act as a suction pump piston during a part of its cycle of operation to remove a pre-used charge from the primary cylinder and to supply a new charge in lieu of the pre-used charge so removed, and to act as a force pump piston during another part of its cycle of operation to return more or less of said pre-used charge into said primary cylinder.

8. In an engine of the character stated, a primary cylinder and its working piston, a secondary cylinder and its working piston, a crank shaft having cranks, connecting rods between said pistons and said cranks, said cranks being set to cause said pistons to operate one in advance of the other, a new charge inlet port to one of said cylinders and an exhaust port for the other cylinder, a port connection between said cylinders, valves for controlling said ports and port connections, and valve actuating devices cooperating with said valves and the aforesaid parts to cause said secondary piston to act as a suction pump piston during one part of its cycle of operation to remove a pre-used charge from the primary cylinder and supply a new charge in lieu of the charge so removed and to act during a second part of its cycle of operation as a force pump to return more or less of such pre-used charge into said primary cylinder, and to act during a third part of its cycle of operation as a working piston.

9. In an engine of the character stated, a primary cylinder and its working piston, a secondary cylinder and its working piston, a crank shaft having cranks, connecting rods between said pistons and said cranks, said cranks being set to cause said pistons to operate one in advance of the other, a new charge inlet port to one of said cylinders and an exhaust port for the other cylinder, a port connection between said cylinders, valves for controlling said ports and port connections, and valve actuating devices cooperating with said valves and the aforesaid parts to cause said secondary piston to act as a suction pump piston during one part of its cycle of operation to remove a pre-used charge from the primary cylinder and draw in a new charge in lieu of the charge so removed and to act during a second part of its cycle of operation as a force pump to return more or less of said pre-used charge into said primary cylinder and to act during a third part of its cycle of operation as a working piston, and to act during a fourth part of its cycle of operation, as an exhausting piston to remove the exhausted charge from said cylinders.

10. In a two-cycle engine, a primary cylinder and its working piston and a secondary cylinder and its piston, a valved port

connecting said cylinders together, a valved working agent inlet port to the primary cylinder, and a valved exhaust port for the secondary cylinder, combined with devices
 5 having provisions for actuating said valves and said pistons to cause said secondary piston to act as a suction pump piston during a part of its stroke to draw a new charge into the primary cylinder, and to cause said secondary piston to act as a force pump to force
 10 a pre-used charge into said primary cylinder during a second part of its cycle of operation, and to cause said secondary piston to act during a third part of its cycle of operation as an exhausting pump to deliver
 15 the exhausted charge to atmosphere.

11. In a two-cycle engine, a primary cylinder and its working piston and a secondary cylinder and its piston, a valved port
 20 connecting said cylinders together, a valved working agent inlet port to the primary cylinder, a valved exhaust port from the secondary cylinder, combined with means for actuating said pistons and said valves
 25 to cause said secondary piston to act as a suction pump piston during one part of its cycle of operation to draw a new charge into the primary cylinder, and to cause said secondary piston to act as a force pump during
 30 a second part of its cycle of operation to force a pre-used charge into the primary cylinder to add its energy to that within the primary cylinder, and to cause said secondary piston to act as a working piston during
 35 a third part of its stroke.

12. In a two-cycle engine, a primary cylinder and its working piston, and a secondary cylinder and its piston, a valved port
 40 connecting said cylinders together, a valved working agent inlet port to the primary cylinder, a valved exhaust port from the secondary cylinder, combined with devices having provisions for actuating said pistons
 45 and said valves to cause said secondary cylinder to act as a suction pump piston during one part of its cycle of operation to draw a new charge of working agent into the primary cylinder, and to cause said secondary
 50 cylinder to act as a force pump during a second part of its cycle of operation to force a pre-used charge into the primary cylinder to add its energy to that within the primary cylinder, and to cause said secondary
 55 piston to act as a working piston during a third part of its stroke, and to cause said secondary piston to act during a fourth part of its cycle of operation as a pump piston to deliver the exhausted charge to atmosphere.

13. In an internal combustion engine, a
 60 primary cylinder and its piston, a secondary cylinder, an intercommunicating port between the two cylinders, a working agent inlet port for the primary cylinder, an exhaust port for the secondary cylinder; combined with mechanical devices coöperating

with the aforesaid parts and having provisions for drawing a fired or pre-used charge from the primary cylinder into the secondary cylinder and simultaneously admitting
 70 a new charge into the primary cylinder and subsequently forcing the withdrawn pre-used charge in whole or in part, back into the primary cylinder to unite with the new charge.

14. In an internal combustion engine, a
 75 primary cylinder and its piston, a secondary cylinder, an intercommunicating port between the two cylinders, a working agent inlet port for the primary cylinder, an exhaust port for the secondary cylinder; combined with mechanical devices coöperating
 80 with the aforesaid parts and having provisions for drawing a pre-used charge from the primary cylinder into the secondary cylinder and simultaneously admitting a new charge into the primary cylinder and subsequently forcing the withdrawn pre-used
 85 charge in whole or in part back into the primary cylinder to unite with the new charge, after the new charge has been pre-used.

15. In an internal combustion engine, a
 90 primary cylinder and its piston, a secondary cylinder and its piston, an intercommunicating port between the said cylinders, a new charge inlet port to the primary cylinder, an exhaust port for the secondary cylinder; combined with devices having provisions
 95 for controlling said ports and controlling the operation of said pistons to cause a pre-used charge to be withdrawn from the primary cylinder into the secondary cylinder while a new charge is admitted into
 100 said primary cylinder to be compressed by the piston therein, and to cause the withdrawn charge to be recompressed and returned in whole or in part to said primary
 105 cylinder after the new charge has been compressed and before its energy has been expended on the primary piston.

16. In an internal combustion engine, a
 110 primary cylinder and its piston, a secondary cylinder and its piston, an intercommunicating port between said cylinders, a new charge inlet port to the primary cylinder, an exhaust port from the secondary cylinder; combined with mechanical devices having
 115 provisions for controlling said ports and said pistons to cause a pre-used charge to be withdrawn from the primary cylinder into the secondary cylinder while a new charge
 120 is admitted into said primary cylinder to be compressed by the piston therein, and to cause the withdrawn charge to be recompressed and returned in whole or in part to said primary cylinder after the new charge
 125 has been compressed and before its energy has been expended on the primary piston, and to equalize the pressure in the two cylinders at times to cause both pistons to move together as one, said mechanical de-
 130

vices including means for opening said exhaust port at times to pass the exhausted charge to atmosphere.

17. In an internal combustion engine, a
 5 primary cylinder and its piston, a secondary cylinder and its piston, port connections between the two cylinders, a new charge inlet port to one of the cylinders, and
 10 an exhaust port for the other cylinder, valves for controlling said ports, a crank shaft, connections between said crank shaft and said pistons, valve actuating devices co-
 15 operatively connected with said crank shaft and said valves and having provisions for operating said valves at predetermined times to cause said secondary piston to withdraw
 20 an exploded charge from said primary cylinder into said secondary cylinder and simultaneously resupply the primary cylinder
 25 with a new charge during a part of the cycle of operation, and to cause said secondary piston to recompress the exploded or pre-used charge in the secondary cylinder and force it in whole or in part back into the
 30 primary cylinder after the new charge in the primary cylinder has been fired and the primary piston is moving on its working stroke.

18. In an internal combustion engine, a
 30 primary cylinder and its piston, a secondary cylinder and its piston, port connections between the two cylinders, a new charge inlet port to one of the cylinders, and an exhaust
 35 port for the other cylinder, valves for controlling said ports, a crank shaft, connections between said crank shaft and said pistons, valve actuating devices coöperatively
 40 connected with said crank shaft and said valves and having provisions for operating said valves at predetermined times to cause
 45 said secondary piston to withdraw an exploded charge from said primary cylinder into said secondary cylinder and simultaneously resupply the primary cylinder with a
 50 new charge during a part of the cycle of operation, and to cause said secondary piston to recompress the exploded or pre-used charge in the secondary cylinder and force
 55 it in whole or in part back into the primary cylinder after the new charge in the primary cylinder has been fired and the primary piston is moving on its working
 60 stroke, said valve actuating devices including provisions for retaining said port between said two cylinders open after the re-compressed pre-used charge is added to the exploded new charge in the primary cylinder to cause an equalization of pressure in the two cylinders and thereby cause the two
 65 pistons to move together in unison during a part of their strokes.

19. In an internal combustion engine, a
 65 primary cylinder and its piston, and a secondary cylinder and its piston, a crank shaft and connecting rods between the cranks of

said crank shaft and said pistons, said shaft having its cranks set to cause its pistons to move one in advance of the other, intercommunicating ports between the ends of said cylinders, a working agent inlet port for admitting new charges centrally into the primary cylinder, a pair of exhaust ports for the secondary cylinder disposed to communicate with said secondary cylinder, intermediate the ends and center thereof, valves for controlling said ports, and means for actuating said valves and said pistons at predetermined times to cause said engine to act as a double acting engine. and cause said secondary piston to withdraw a pre-used charge from one end of the primary cylinder into the corresponding end of the secondary cylinder during one part of the cycle of operation of the secondary piston, and simultaneously admitting a new charge of working agent into the evacuated end of the primary cylinder, said secondary piston serving during a second part of its cycle of operation to recompress the pre-used charge that was withdrawn from the primary cylinder into the secondary cylinder and return it in whole or in part to the corresponding end of the primary cylinder.

20. In an internal combustion engine, a
 70 primary cylinder and its piston, a secondary cylinder and its piston, intercommunicating ports between the ends of said cylinders, control valves in said intercommunicating
 75 ports, a working agent inlet port for admitting new charges centrally into the primary cylinder, a pair of exhaust ports for the secondary cylinder disposed to communicate
 80 with said secondary cylinder intermediate the ends and center thereof, valves for controlling said exhaust ports, a crank shaft, connections between said crank shaft and
 85 said pistons to cause said pistons to operate, valve actuating devices for all of said valves coöperatively connected with said crank shaft and having provisions to open and
 90 close said valves at predetermined times to cause said engine to act as a double acting engine throughout its cycle of operation and to cause said secondary piston to withdraw
 95 a pre-used charge from one end of the primary cylinder into the corresponding end of the secondary cylinder during one part of the cycle of operation of said secondary piston and simultaneously permit a new charge
 100 of working agent to enter through the working agent inlet port into the evacuated end of said primary cylinder, and to cause said secondary piston during a second part of its
 105 cycle of operation to re-compress the pre-used charge that was withdrawn from the primary cylinder into the secondary cylinder and return it in whole or in part to the corresponding end of the primary cylinder, and to hold said valve of said inter-
 110 communicating port between said corre- 130

sponding ends of said cylinders open to equalize the pressure in said corresponding ends of said cylinders during a part of the cycle of operation of said pistons to cause
5 said new exploded charge and said pre-used charge to simultaneously act on both pistons and move them in unison.

21. A compound internal combustion engine including a main and a secondary cylinder and their pistons, a common crank shaft having cranks connected with said pistons and set to operate one piston in advance of the other, one of the cylinders having a valve controlled inlet port and the
10 other having a valve controlled exhaust port and the cylinders having a valve controlled intercommunicating port; mechanical devices for opening and closing the respective valves at predetermined times in the cycle
15 of operation of the machine to cause the secondary piston to act as a pump piston for supplying a new charge to the primary cylinder and simultaneously drawing a pre-used charge from the primary cylinder into
20 the secondary cylinder during one part of its cycle of operation, then causing said primary piston to compress said new charge while said secondary piston forces an exhausted charge to atmosphere, then causing
25 said new charge to be ignited to act on said primary piston and also cause said sec-

ondary piston to return said pre-used charge in whole or in part to said primary cylinder to unite with the exploded new charge and thereby expend its energy also on said secondary piston to cause it to move on its working stroke as said primary piston moves on its working stroke. 35

22. In an internal combustion engine of the compound type, the combination of two
40 separate cylinders and their pistons, a common crank shaft connecting the rods between the crank shaft and the pistons, said cylinders each having suitably controlled individual and interconnecting ports, all being
45 arranged to cause a charge of air and fuel to enter one of said cylinders to be compressed by the piston in said cylinder and to cause the other piston and cylinder to assist in charging the first cylinder during a
50 part of the cycle of operation and for causing both pistons to act in unison as working pistons during another part of the cycle of operation of the engine and for exhausting
55 a predetermined quantity of the burnt gases to atmosphere during another part of the cycle of operation of the engine.

WM. J. WRIGHT.

Witnesses:

ALBERT E. DIETERICH,
JOHN T. SCHROTT.