L. E. FISH.

POWER APPARATUS.

APPLICATION FILED NOV. 10, 1910.

1,021,241.

Patented Mar. 26, 1912.

2 SHEETS—SHEET 1.

Fig. 1.

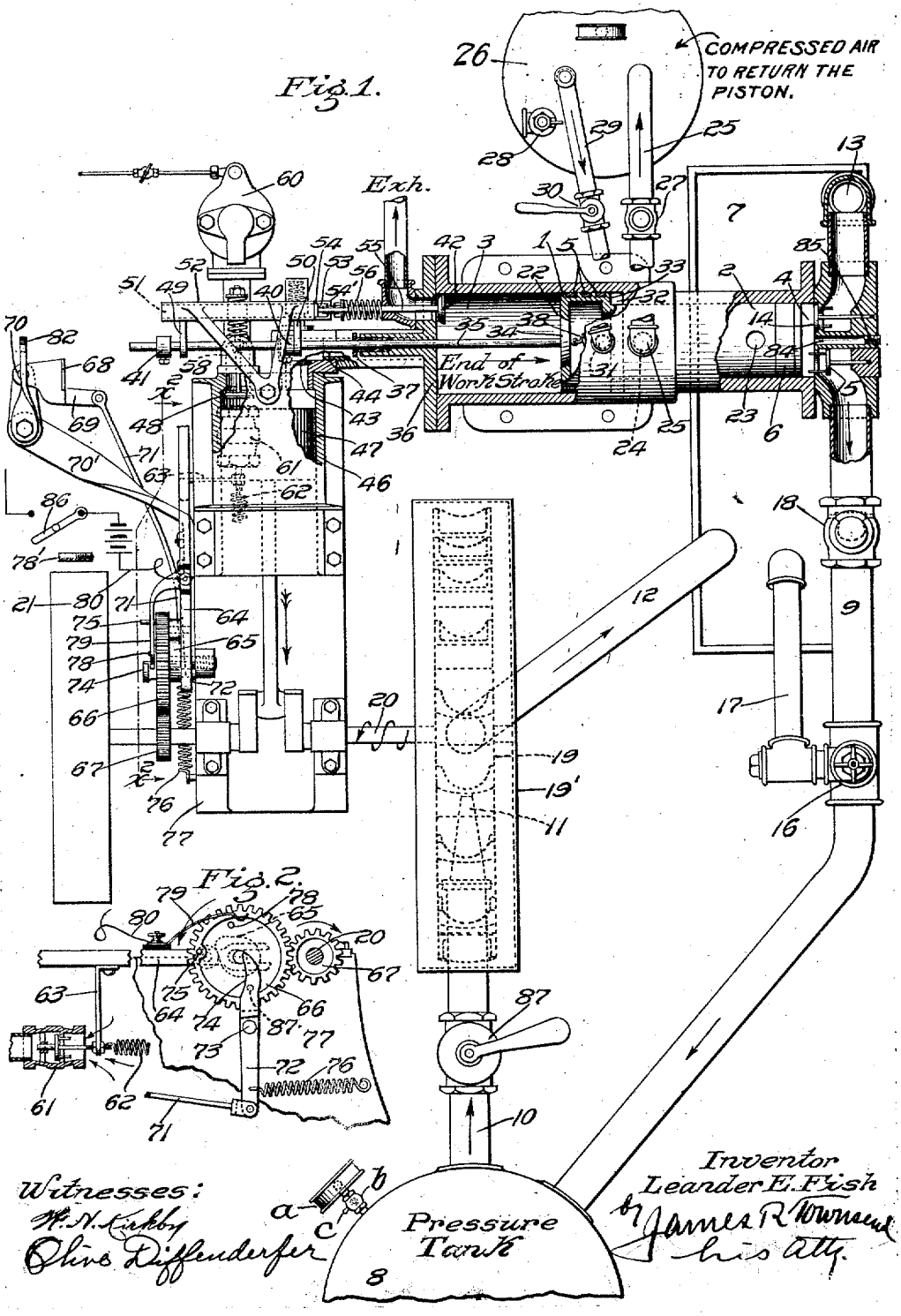

Fig. 2.

Witnesses:
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his Atty.

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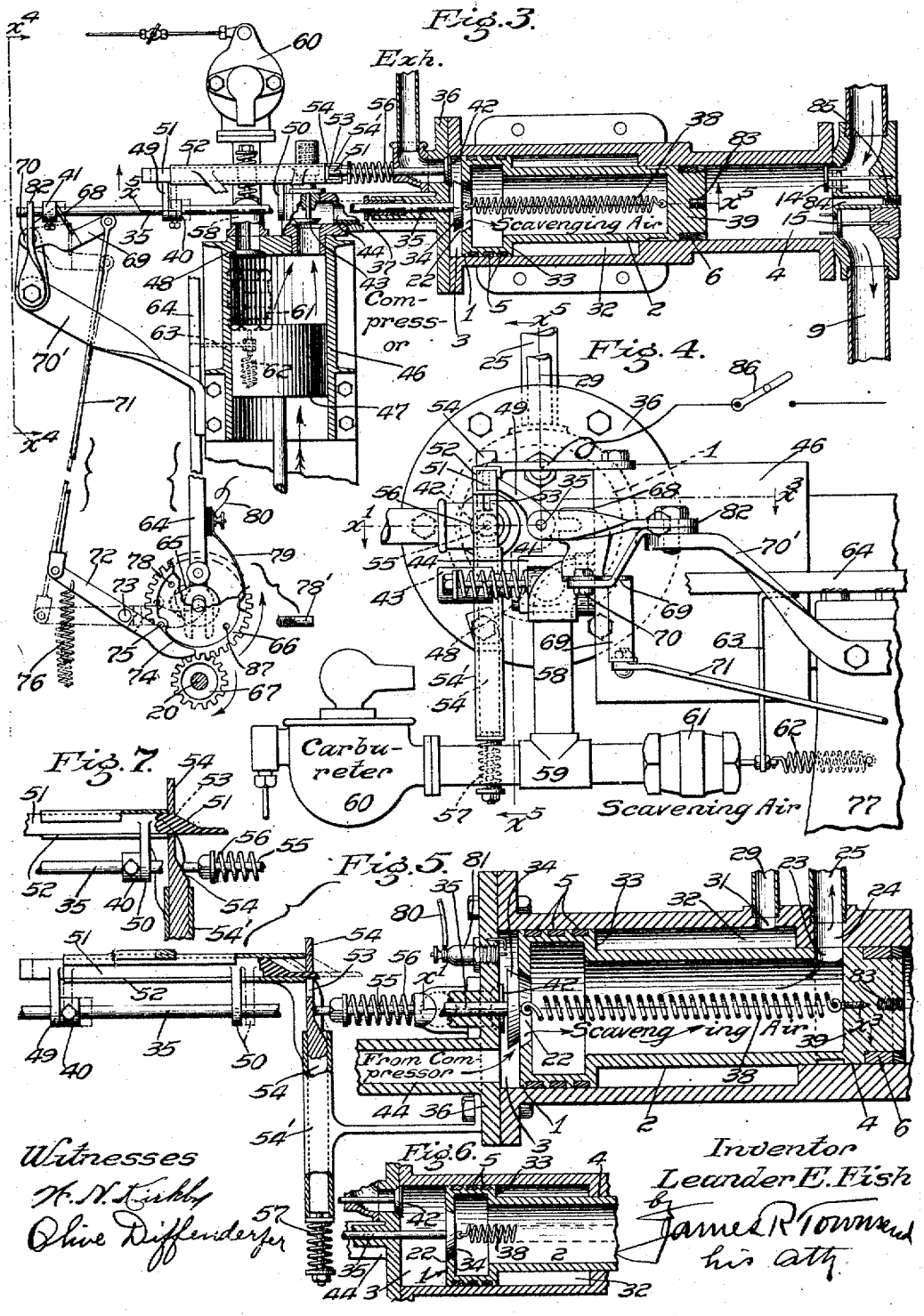

Witnesses
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UNITED STATES PATENT OFFICE.

LEANDER E. FISH, OF LOS ANGELES, CALIFORNIA.

POWER APPARATUS.

1,021,241. Specification of Letters Patent. Patented Mar. 26, 1912.

Application filed November 10, 1910. Serial No. 591,708.

To all whom it may concern:

Be it known that I, LEANDER E. FISH, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Power Apparatus, of which the following is a specification.

The objects of this invention are: economy of fuel; economy of application of the power produced by combustion; superior cooling of the parts of the internal combustion engine; elimination of all crank shaft losses in the transmission of the generated power to the work to be performed; and maximum production of power for minimum capacity of combustion chamber.

The invention is applicable in various forms to both steam and internal combustion engines.

The invention may be applied in combustion types of engine either as a four-cycle or as a two-cycle engine and provision may be made whereby the same engine may be transformed from a four-cycle to a two-cyle engine by simply disconnecting the scavenging valve and inserting a second sparking pin in the timing mechanism.

The invention will be illustrated as an internal combustion engine which is transformable from four-cycle to two-cycle and vice versa.

The accompanying drawings illustrate the invention in one of the forms in which it may be applied in apparatus having an internal combustion engine as a prime mover.

Figure 1 is a plan broken in parts and sectioned in parts to illustrate an engine constructed in accordance with this invention. The partial section is taken on line x^1—x^3, Figs. 4 and 5. The combined piston and plunger is shown at the end of the work stroke. The parts are arranged for four-cycle operation. Fig. 2 is an elevation from line x^2, Fig. 1, the scavenger air valve being shown in axial section and just opening to admit air to the compressor at the suction stroke. A fragment of the engine base is shown. Fig. 3 is a fragmental view mainly in plan section analogous to Fig. 1 showing parts of the engine receiving a charge of scavenging air from the compressor. Portions of the timing mechanism are in broken elevation, being thus displaced to illustrate in this one view the position of the parts that operate to effect the scavenging. Fig. 4 is a fragmental enlarged end elevation viewed from line x^4, Fig. 3. Parts are in positions shown in dotted lines in Fig. 3. Fig. 5 is an enlarged fragmental vertical section on line x^5, Figs. 3 and 4. Parts are in the same position as in Fig. 3. Fig. 6 is a fragmental plan section analogous to Figs. 1 and 3 showing position of parts at the moment of ignition. Fig. 7 is a fragmental detail showing parts of the exhaust timer in the position they assume while holding the exhaust valve open.

In Figs. 1 and 3 the two-cycle contact pin is shown detached and in enlarged scale.

The power receiving and transmitting element is a combined free piston and plunger having a piston head 1 of one diameter and a plunger body 2 of less diameter mounted in a cylinder having a bore of two diameters forming a piston chamber 3 to fit the piston head 1 and a plunger chamber 4 to fit the plunger 2. The peripheral faces of the piston head and plunger body may be formed after the manner of other piston heads and other plunger bodies; there being packing rings 5 and 6 arranged as required to make the piston and the plunger work without leakage in the piston and plunger chambers.

The free piston element may be driven by any suitable impelling medium as steam or gas and may operate upon any transmitting medium as oil, water, air or other fluid; either driving liquid against pressure or compressing fluid after the manner of a liquid or air pump. In the apparatus shown the fluid medium operated upon is a liquid as water or oil and the same is contained in a sump 7, a pressure tank 8, and the connecting pipes 9, 10, 12 and 13, including the nozzle tip 11, and a motor wheel and case which complete a circuit from the plunger chamber 4 through the pipe 9 to the pressure tank 8 thence through the nozzle supplying pipe 10, nozzle 11, drain 12, sump 7 and suction pipe 13; there being provided suction and discharge valves 14 and 15 to direct the fluid from the sump to the pressure tank. The delivery pipe 9 may be provided with a pressure regulator 16 connected with a by-pass pipe 17 that discharges surplus water into the sump 7. Said pipe 9 is also provided with a check valve 18 to prevent return of the fluid.

The nozzle 11 is arranged to drive a rotary motor as the water wheel 19 which is contained in the case 19′ and may be of any desired type and character and drives a

power shaft 20 having a fly-wheel pulley 21 which may be used for transmitting power.

The combined free piston and plunger is hollow and is provided with an inlet 22 through the piston head and an outlet 23 through the plunger body; the inlet 22 communicating between the piston chamber 3 and the interior of the piston; and the outlet 23 communicating through a port 24 in the cylinder and through a pipe 25 with a compressed air tank 26. Said pipe 25 is provided with a check valve 27 to prevent the return of pressure from said tank 26 which is provided with a regulatable relief valve 28 to allow the escape of scavenging air and to retain sufficient pressure to afford a resilient medium to return the free piston element to the intake end of the cylinder chamber 3. For the purpose of thus returning the free piston element, the air tank 26 is connected through a pipe 29 having a throttle valve 30, and through a port 31, with the annular piston return chamber 32, which surrounds the plunger body 2 in front of the annular return face 33 of the piston head. The purpose of directing the scavenging air through the air tank 26 is simply to maintain in the tank a definite uniform air pressure sufficient to form a spring to return the piston at a uniform speed.

The free piston element has three active faces; the first or driving face, practically including the scavenging valve 34, and being at the rear end of the piston head and practically equal in area to the cross section of the piston chamber 3; the second or plunger face being at the front end of the plunger and practically equal in area to the cross section of the plunger chamber 4; and the third or return face being an annular shoulder 33 at the junction of the piston and the plunger body so that the area of the first active face is practically equal to the combined area of both the other active faces.

The combined piston and plunger is provided with a scavenging valve 34 having a valve stem 35 sliding through the main cylinder head 36 which is provided with a gland 37 to prevent leakage of pressure around the valve stem; and said valve is normally seated in the port 22 by a spring 38 fastened at one end to the valve and at the other end to the inside of the plunger head 39 so that the normal tendency of the scavenging valve is to remain closed and to travel with the element. The scavenging valve stem is provided with adjustable collars 40 and 41 by which the actuation of the exhaust valve 42 is effected. By adjusting the collar 40 along the valve stem the strokes of the exhaust valve may be changed.

The fuel and the scavenging air are supplied through a valve 43 at inlet 44 from an ordinary air compressor comprising a cylinder 46 and piston head 47, or any well-known equivalent thereof. Said compressor constitutes means to supply fuel and air; and in the form illustrated, the compressor cylinder 46 is provided with a supply valve 48 to admit the supplies of fuel and air alternately, under suction to the cylinder 46 as the piston 47 retreats. The stroke of the piston 47 which admits the charge of air through the carbureter on its way to the piston chamber 3 to supply fuel to said chamber is termed the first suction stroke and the stroke of the piston which draws in air to the cylinder 46 for the purpose of forcing scavenging air through the chamber 3 is termed the second piston stroke. It is to be noted that at the end of the working stroke a determined pressure in the tank 26 will operate against the annular face 33 to return the element toward the main cylinder head 36. During the return stroke of the element the scavenging valve will remain closed and it is necessary that the exhaust valve be open so that the exhaust will take place.

The collar 40 on the scavenging valve rod operates between and is adapted to act alternately upon two arms 49 and 50 of the sliding wedge 51 that moves in a guide 52 and works in a slot 53 of the exhaust-valve wedge-slide 54 to reciprocate such slide. The exhaust valve opens inward toward the free piston element and is provided with the exhaust valve stem 55 by which it may thus be opened against the pressure of the exhaust valve spring 56 which normally holds the exhaust valve closed. During the working stroke the scavenging valve 34 is held closed by the pressure in the chamber 3 and at the close of such stroke the collar 40 strikes upon the arm 50 and moves the wedge 51 into the position shown in Fig. 7, thus opening the exhaust valve preparatory for the return stroke. The collar 40 is adjusted on the scavenging valve rod 35 at such position that the wedge slide 54 will be moved in its guide 54′ to act on the exhaust valve stem 55 to open the exhaust valve 42 against the pressure of the exhaust valve spring 56 when the free piston element has come within, say about, the half inch of the ends of the cylinder and plunger chambers. The port 31 is a short distance, say one-half inch, from the end of the annular chamber 32 so that an air cushion for the annular piston face 33 is provided to stop the free piston element on the forward stroke practically at the moment the exhaust valve is opened. While the resilient medium, as compressed air, in the chamber 32 returns the free piston element, the sliding wedge 51 remains in the position shown in Fig. 7, thus holding the exhaust valve open during the return stroke of the free piston element and the collar 40. The space between the arms 49 and 50 of the sliding wedge 51 is shorter by

about one-half inch, more or less, than the length of the working stroke of the free piston element, plus the thickness of the collar 40, so that at the close of the return stroke the collar 40 will act upon the arm 49 while the scavenging valve is seated, thus to withdraw the wedge 51 from the position shown in Fig. 7, and allow the wedge slide 54 to be retracted by the spring 57 from the exhaust valve stem 55, thereby to allow the spring 56 to close the exhaust valve just before the free piston element reaches the head of the cylinder. Thereupon all of the valves for closing the openings into and from the working chamber 3 will be closed at the end of the exhaust stroke to form an air cushion to stop the free piston element before it reaches the rear cylinder head 36.

The compressor intake 58, see Figs. 1 and 4, is connected to the T 59 with the carbureter 60 on one side and the air valve 61 on the other side. Said air valve is normally closed by the spring 62 and is connected with a valve arm 63 which is operated by the air valve rod 64 that is operated against the force of the air valve closing spring 62 by the cam 65 of the two-to-one timing mechanism comprising the large gear 66 driven by the small gear 67 which is fixed on the power shaft 20.

A scavenging valve rod latch is provided to retract and to constrain the scavenging valve rod to open and hold open the scavenging valve during one compressing stroke of the compressor. Said latch comprises a fork 68 that may straddle the valve rod 35 to engage behind the valve rod collar 41 and is mounted on a lever 69 which is pivoted at 70 to an arm of a support 70′ and is operated through a connecting rod 71 by a cam lever 72 that is pivoted to a support at 73 and is provided with a curved face 74 in the path of the pin 75 on the large gear 66 of the timing mechanism. Said cam lever 72 is retracted by the retracting spring 76 connected to the base 77 of the engine; and the curved cam face 74 is of such dimensions and has such amplitude that the stroke of the lever 72, and consequently of the latch mechanism, extends through one-fourth of the revolution of the large gear 66 to open and hold open the scavenging valve 34 after the return stroke of the free piston element. When the pin 75 escapes the curved face 74 the scavenging valve rod is released and the spring 38 closes the scavenging valve 34.

The contact point 78 on the large timing gear 66 contacts with the contact spring 79 of the electric circuit 80 which is connected with the igniter 81. The igniting circuit is closed by the timing mechanism once at each revolution of the large wheel 66; and this occurs at the beginning of the second suction stroke after the piston chamber 3 has been charged with a charge of fuel from the first suction stroke, the scavenging valve being closed. The igniting mechanism is timed to produce a spark in the chamber 3 at the end of half a cycle after the scavenging valve rod 35 is released, and the air-valve rod 64 which opens the spring closed air valve 61 and thus controls the introduction of scavenging air and fuel charges, alternately, is actuated by the cam 65.

The valve rod stay 82 is supported on the arm 70′ that is fixed to the engine frame and in said stay the scavenging valve rod extends so as to be steadied thereby against the lateral thrust of the latch while the valve 34 is opened.

The piston rod 35 is held normally in true position by two arms 49 and 50 and it is only necessary to support the end of said rod 35 against the lateral thrust of the fork 68 of the latch which occurs only when the rod 35 is in the retracted position shown in Fig. 3.

When the free piston element has come to rest after being returned by pressure in the annular chamber 32, the collar 41 is in position to be engaged by the fork 68 of the valve rod latch. The timer cam 65 operates the air valve rod 64 to open the air valve 61 to admit a charge of scavenging air to the compressor chamber just before the pin 75 engages the curved face 74. At the next compressing stroke of the piston 47 the pin 75 operates through the intermediate parts to move the latch fork 68 to engage behind the collar 41 and retract the rod 35 thus to open the scavenging air valve as the compressor piston makes its compressing stroke upon the charge of air which has been drawn into the compressor through the valve 43 for the compressing stroke. At this compression stroke the scavenging air is driven through the hollow free piston element, which being at the end of its return stroke has brought the ports 23 and 24 into register with each other, so that the scavenging air internally cools the element and then flows into the tank 26 and thence out through the relief valve at a determined pressure. The relief valve 28 will be set so that the pressure on the annular face 33 is such as to return the element at a speed which may be determined by adjusting the throttle valve 30. In practice such speed will be sufficient to allow the free piston element to come to rest on its return stroke before the fork 68 has engaged the collar 41. The strength of the spring 38 is preferably slight being sufficient to normally hold the scavenging valve seated, and insufficient to normally move the free piston element, and as the free piston element is returned from the working stroke the exhaust valve is open and the other valves closed until the free piston element has reached a point within, said one-half inch, more or less, of the head of the cylinder; and thereupon the timing mecha-

nism releases the exhaust valve 42 allowing the free piston element to come to rest against an air cushion. Immediately thereafter the timing mechanism opens the scavenging valve and the compressor operates to drive the scavenging air through the hollow element into the air tank 26 to maintain a pressure therein sufficient for returning the element after the next working stroke; any surplus pressure being allowed to escape through the relief valve 28. At the beginning of the scavenging stroke of the compressor piston the air inlet valve 61 is allowed to close under the action of the spring 62; the cam 65 having escaped the valve rod 64, and thereupon the compressor sucks in a charge of fuel from the carbureter 60 as the piston 47 retreats on the next stroke and at the next advance of the piston 47 the charge of fuel is compressed into the chamber 3 and as the scavenging valve 34 and the exhaust valve 42 are now closed the pressure is applied to the piston head and starts it on its working stroke. This starts the plunger on its working stroke and sets into motion the body of liquid in the plunger chamber and when such movement is initiated the timer causes ignition of the charge of fuel, under the force of which the free piston element completes its working stroke, thus forcing the water through the circulating system to drive the motor 19 and consequently the compressor so that the apparatus is selfcontained and a maximum amount of the power generated by the combustion of the fuel is utilized; there being no crank shaft losses, except in the compressor in case a compressor of the form shown is employed, and such crank shaft losses may be avoided by a direct acting compressor, not shown, which may be connected by a connecting rod, not shown, screwed into the socket 83, that may be led through the way 84, the plug 85 being removed for that purpose.

An air gage *a* is connected with the pressure tank 8 through a pet cock *b* having a nipple *c* to receive the hose of an air pump, not shown, by which initial pressure in the tank 8 may be produced after the said tank has been filled with water above the level of the pipes 9 and 10. Initial pressure may be produced in the tank 26 by manually opening the scavenging valve 34 and then turning over the wheel 21 until sufficient pressure is stored in the tank 26 to return the piston. Then the scavenging valve may be closed. Then the switch 86 of the electric igniting system will be closed and the valve 30 opened. The full-way gate 87 will then be opened, whereupon the engine starts, and the operation thereafter is automatic as above stated. Thus a four-cycle gas engine is operated, the compressor, the front end of the cylinder and the connections constituting means to apply an expansive medium to one side of the free piston element to move it in one direction at one pressure and one speed; the electrical igniter constituting means to explode the fuel to move the piston at another and higher pressure and speed on its working stroke; and the rear end of the cylinder, the valves 14 and 15, the circulating system from 9 to 13 constitute means to apply a power transmitting medium as air, oil or water to the other side of said element, to transmit motion from the element to the motor without the intervention of mechanical means between said element and medium, other than the medium between the element and the motor.

The large timer wheel 66 is provided with a socket 87 to receive a detachable contact pin 78′ and hold it diametrically opposite the contact pin 87 so that the circuit will be closed and opened twice at each revolution of the large timer wheel 66.

When the pressure in tank 26 is once established it remains practically constant as the puppet valve 28 only discharges the excess pressure.

By detaching the arm 63 and the connecting rod 71 so that the compressor will supply fuel at every stroke, and the latch will not open the scavenging valve, the engine is converted into a two-cycle engine the air pressure from the tank 26 acting as a spring to return the piston.

To operate the apparatus by steam; the air compressor, the timing mechanism, the latch and the igniting mechanism will be disconnected, and the steam will be admitted through the inlet 44 and the exhaust valve will be operated as before described.

I claim:—

1. A free piston element constituting a piston and a plunger and being provided with a plunger face and two opposed piston faces; means forming separate chambers for said faces, respectively; a circulating pressure system connected with the plunger chamber and including means whereby power may be transmitted through a medium to operate power mechanism; such medium; such power mechanism arranged in said circulating system; means to supply fuel to the one piston face under sufficient pressure to move the element and operate the plunger in opposition to the pressure of said system; means to ignite the fuel after the element has begun to move in opposition to the system pressure, thus to complete the power stroke of the plunger; and means to apply pressure to the other piston face to return the element and to operate the plunger on its suction stroke.

2. A free piston element constituting a piston and a plunger provided with a plunger face and with two piston faces, the latter being opposed to each other; a cylinder forming separate chambers for the faces, re-

spectively; means to admit fluid to the plunger chamber at the advance of the element; means to discharge fluid under a determined pressure from the plunger chamber at the return of the element; means to apply fuel to one of said chambers under a pressure sufficient to start the element to discharge the fluid under said determined pressure; means to ignite the fuel after the piston has started, and means to apply pressure to the other piston face to return the piston.

3. A hollow free piston element constituting a piston and a plunger provided with a plunger face and with two piston faces, the latter being opposed to each other; a cylinder forming separate chambers for the faces, respectively; means to admit fluid to the plunger chamber at the advance of the element; means to discharge fluid under a determined pressure from the plunger chamber at the return of the element; means to apply fuel to one of said chambers under a pressure sufficient to start the element to discharge the fluid under said determined pressure; means to ignite the fuel after the piston has started; means to apply pressure to the other piston face to return the piston; means to open a passage through the element after the completion of the advance stroke, and means to force air through such element.

4. A hollow free piston, provided with an inlet and an outlet, and with opposed piston faces and a plunger face, a cylinder forming separate chambers for the faces respectively, means to apply power to one of the piston faces to advance the piston, means to close the piston inlet while such power is being applied, means to apply power to the other piston face to return the piston, and means to open the piston inlet and outlet on return of the piston.

5. In an internal combustion engine, a cylinder and a hollow piston therein, said piston having an inlet and an outlet and means for closing and opening said inlet and outlet, means to force a cooling medium through the piston for the purpose of internally cooling the piston, and means for applying pressure from the cooling medium to move the piston.

6. In an engine the combination with a cylinder of a hollow piston having an inlet and an outlet, an inlet valve to control the inlet in the piston and having a stem extending through the cylinder head, means to supply a cooling medium to said inlet, and latch means for the valve stem to open the inlet.

7. The combination of the cylinder of an internal combustion engine, exhaust means therefor, a hollow piston therein having an inlet and an outlet, a valve for the inlet, said valve being provided with a stem extending through the cylinder, a compressor to supply air and fuel to the cylinder, means connected with the compressor to alternately supply air and fuel to the compressor, means to ignite the fuel in the cylinder to advance the piston, means to return the piston, latch means to retract the valve stem to open the inlet, and timing means whereby the inlet valve is opened to receive air after the return of the piston.

8. In an internal combustion engine the combination with a cylinder of a hollow piston therein provided with an inlet and an outlet, a scavenging valve for the inlet, a compressor connected with the inlet, a spring connecting the valve with the piston to seat the valve, a valve stem extending through the cylinder head to open the valve, an exhaust valve, means between the valve stem and the exhaust valve to open the exhaust valve, latch means to open the scavenging valve to receive a charge from the compressor, an igniter, and timing mechanism to operate the igniter and the latch.

9. In an internal combustion engine the combination with a cylinder, a compressor and means to supply the compressor and the cylinder with alternate charges of fuel and air, of an igniter to ignite fuel in the cylinder, a hollow piston in the cylinder, provided with an inlet and an outlet and adapted to be advanced by the ignited fuel, a valve for the inlet, a stem for the valve, latch means to normally close the valve, means to retract the valve stem to open the valve, an exhaust valve, means to normally close the exhaust valve, means to return the piston, means operated by the valve stem and adapted to open the exhaust valve and to hold it open during the return of the piston, and means operated by the compressor to time the latch means and the igniter.

10. A power apparatus comprising a free piston, a cylinder therefor, a compressor to charge the cylinder with fuel, an exhaust valve, means between the piston and the exhaust valve to open the exhaust valve and hold it open during the return stroke of the piston, an igniter to ignite the fuel to advance the piston, and timing mechanism between the compressor and the igniter to ignite the fuel in timed relation with the compressor.

11. In a power apparatus a compressor, means to supply fuel to the compressor, means operated by the compressor to time the fuel supply, a cylinder, an igniter to ignite fuel in the cylinder, a free piston in the cylinder, an exhaust valve for the cylinder, a wedge slide to open the exhaust valve, a sliding wedge to operate the wedge slide to open and hold the exhaust valve open, and means between the free piston and the sliding wedge to operate said wedge at opposite ends of the piston stroke.

12. In an internal combustion engine hav-

ing a cylinder a hollow free piston to receive the impulse and to be advanced thereby, and means to open a passage through said piston to allow a cooling medium to flow therethrough, means to supply such medium under pressure, and means to apply the pressure of such medium to return the piston.

13. A free piston; a cylinder for the piston; means including a compressor to supply fuel to the cylinder; means, including a fluid medium operated by the piston to drive the compressor; igniting means controlled by the compressor to ignite the fuel in the cylinder; and exhaust means controlled by the piston to exhaust the burned gases.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 4th day of November, 1910.

LEANDER E. FISH.

In presence of—
JAMES R. TOWNSEND,
L. BELLE RICE.