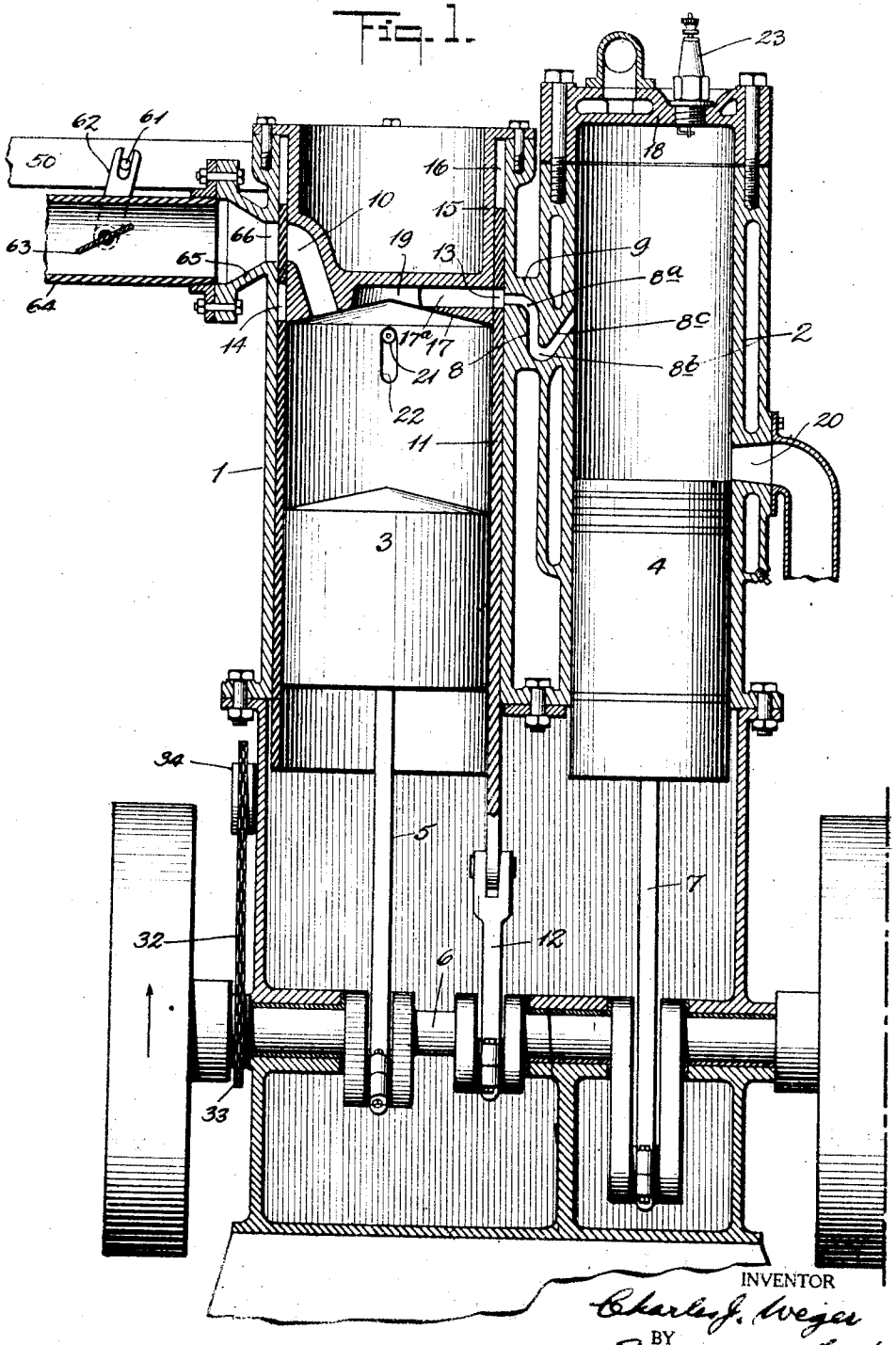
Jan. 5, 1926. 1,568,431

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INTERNAL COMBUSTION ENGINE

Filed April 26, 1924 3 Sheets-Sheet 1

Fig. 1.



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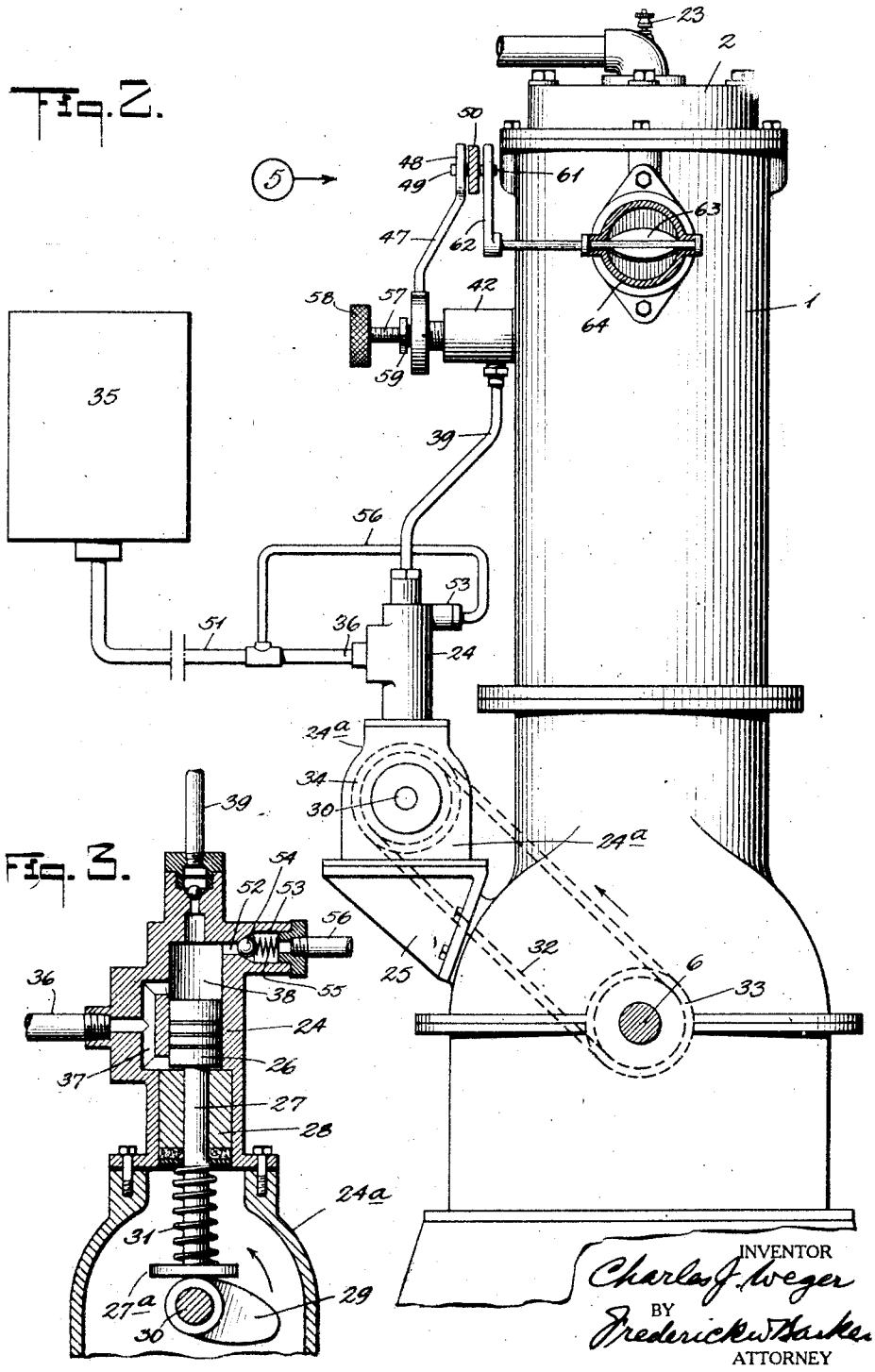
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Fig. 2.



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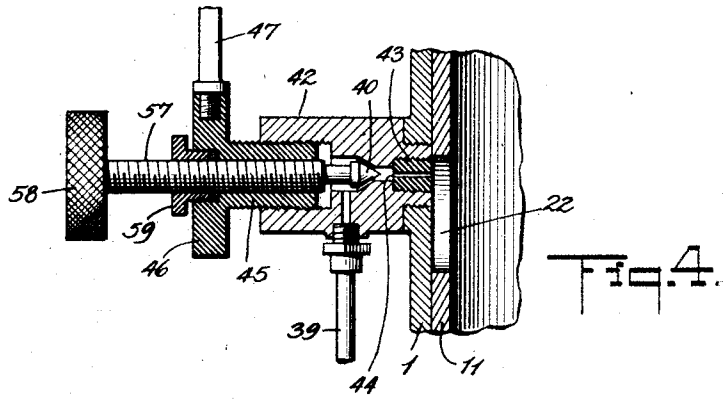


Fig. 4.

Fig. 5.

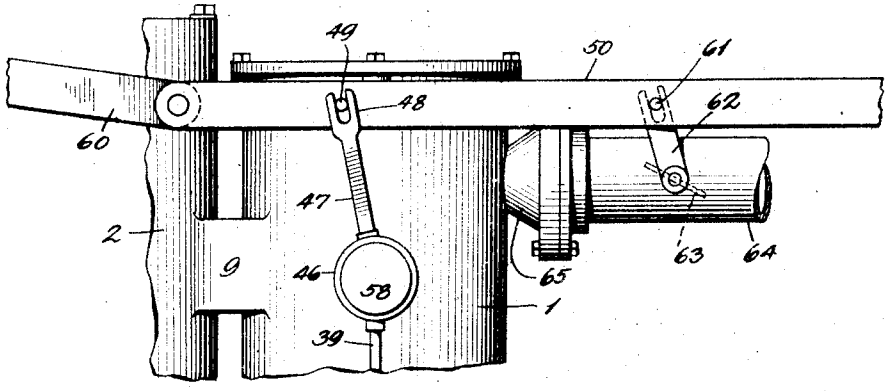
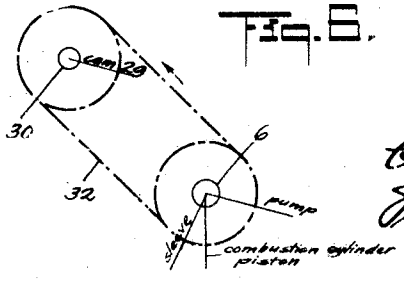


Fig. 6.



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UNITED STATES PATENT OFFICE.

CHARLES J. WEGER, OF CLEVELAND, OHIO.

INTERNAL-COMBUSTION ENGINE.

Application filed April 26, 1924. Serial No. 709,092.

To all whom it may concern:

Be it known that I, CHARLES J. WEGER, a citizen of the United States, residing at the city of Cleveland, county of Cuyahoga, State of Ohio, have invented a new and useful Improvement in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines, and my improvements are directed particularly to an engine of the type employing separate pump and combustion cylinders, wherein the combustion cylinder operates on the two-stroke cycle principle.

Mainly my invention consists in the provision of means for thoroughly scavenging the combustion cylinder, after every power stroke, with fresh air introduced therein from the pump cylinder, this introduction of fresh air continuing until the exhaust port closes, whereafter, during the initial portion of the compression stroke in the combustion cylinder, the continued delivery of air thereinto carries a predetermined charge of liquid fuel which is appropriately timed and injected into the pump cylinder for that purpose.

Very high efficiency is attained with my improved engine, due in large measure to these causes:

(1) The new charge of gaseous mixture enters a combustion cylinder that has been swept clear of the consumed and partly consumed products of the preceding power stroke.

(2) The mixing of this charge begins in the pump cylinder during a compression stroke therein, the pump piston and cylinder head having complementary opposed conoidal surfaces which prevent the presence of dead spaces.

(3) The mixture of liquid fuel and air is forced through an angled passage into the combustion cylinder, this passage presenting surfaces to be bombarded by the fuel particles, which are thereby smashed and further comminuted, and also the streams of fuel particles are caused to intersect each other in the angled passage, which thus constitutes a mixing conduit; heat needed for vaporization being obtained by the transformation of kinetic energy into heat at impact, also by the absorption of heat from the hot walls.

(4) Further, the angled passage is directed upwardly toward its opening into the combustion cylinder, so that the scavenging air issuing into that cylinder is forced toward the cylinder head, and, aided by continued flow, mushrooms downwardly to force out the burnt gases; also that the stream of mixture in taking the same upward course becomes better commingled by striking against the cylinder head and being angularly reflected therefrom, and by the effect of turbulence, maintained during the continued flow from the angled passage.

Also my invention includes novel means for delivering predetermined metered charges of liquid fuel to the pump cylinder, as well as joint means of control for the air and fuel supplies.

The improvements comprised in this application have resulted from my continued experiments since the date of my original application, Serial No. 833,882, filed April 23, 1914; which matured into Patent No. 1,206,741, dated Nov. 28, 1916.

Other features and advantages of my invention will hereinafter appear.

In the drawings:

Figure 1 is a side sectional elevation of my improved engine, being a single unit thereof including pump cylinder and combustion cylinder.

Fig. 2 is a front elevation thereof.

Fig. 3 is an enlarged, sectional, partial view in elevation, of the fuel delivering means.

Fig. 4 is a sectional detail view showing the adjustable fuel metering means.

Fig. 5 is a partial side elevation, looking in the direction of the arrow in Fig. 2, and

Fig. 6 is a diagram of the crank shaft, showing the angular relation of the cranks for the pump piston and sleeve valve to the power piston, also showing the cam shaft and the relative angularity of the cam for operating the fuel delivery pump.

In the engine unit presented by way of example in the drawings accompanying this application, let 1 indicate an air pump cylinder and 2 a combustion cylinder. These cylinders are placed side by side and are provided respectively with the pistons 3 and 4, the piston 3 serving the pump cylinder and the piston 4 serving the combustion cylinder. A rod 5 connects the piston 3 with the crank shaft 6 and similarly a rod 7 connects piston 4 with the same crank shaft.

However, the crank settings of rods 5 and 7 have different angularity, for reasons which will appear hereinafter.

The pump cylinder has greater volumetric capacity than the combustion cylinder, because it is required to supply air to the latter for scavenging purposes during the same stroke in which it subsequently charges said combustion cylinder with fuel and air mixture.

An angled transfer passage 8 extends through the wall of cylinder 2 and through a web 9 which connects the cylinders 1 and 2. This passage, also an air intake passage 10 through the wall and head of cylinder 1, are controlled by a sleeve valve 11 that is reciprocable within cylinder 1 and is operated by the crank shaft through a connecting rod 12. The valve 11 has a port 13 to co-act with passage 8, and a port 14 to co-act with passage 10. The head portion 15 of cylinder 1 has an annular clearance 16 extending above the upper interior end 17 of said cylinder, to accommodate the sleeve 11 in its reciprocatory movement; the cylinder head proper, which contains a continuation of transfer passage 8, lying in a lower plane than the head 18 of cylinder 2. One reason for this arrangement is that thereby the transfer passage may have its opening into the combustion cylinder at a point about midway the extent of its piston stroke, to thereby serve certain important functions, as will presently appear.

The continuation 17^a of transfer passage 8 through cylinder head 17 communicates with the interior of cylinder 1 through a port 19 located centrally of head 17. It will be noted that the interior surface of head 17 is convex, or of conoidal form, and that the opposed surface of piston 3 is of complementary contour. This conformation facilitates the mixing of fuel and air in the cylinder as the piston is rising, by centering the mass toward the port 19, and eliminating dead spaces such as would be present if the piston and head surfaces were flat. It is necessary that the piston 3 should have only a slight clearance from the head 17 when at the top of its stroke in order that nearly the entire charge may be transferred into the combustion cylinder.

The combustion cylinder is provided with an exhaust port 20 located at a point in its wall where it is controlled by piston 4, near the end of its power stroke. An opening 21, through the wall of cylinder 1, is provided for the passage of a charge of liquid fuel, which is to be injected therein by suitable pressure means, and a slot 22 in the sleeve 11 is adapted to register with opening 21 during that portion of the sleeve movement which occurs while port 13 uncovers the transfer passage 8.

The diagram, Fig. 6, shows the crank angle for the combustion cylinder piston to be about 70° behind that of the pump piston, while the crank angle for the sleeve valve is about 30° behind that of the combustion cylinder piston.

Therefore, in the operation of my improved engine the pump piston begins its down stroke while the combustion cylinder piston is performing its compression stroke, (Fig. 1) said down stroke of the pump piston starting from the top dead centre of its crank, while the sleeve valve is moving upwardly through the major speed sweep of its crank, in which motion the sleeve port 14 quickly and fully enters into registry with intake passage 10, and maintains said passage entirely uncovered, with the sleeve crank then passing over its dead centre, while the pump piston performs its down stroke, so that the flow of air into the pump cylinder may be unrestricted throughout the intake stroke.

It should be noted that the sleeve port 13 remains out of registry with transfer passage 8 all during the pump piston downstroke, so that the transfer passage in held closed; also that the combustion cylinder piston in the same period has completed its compression stroke, and has performed the major portion of its expansion or power stroke.

Fig. 1 shows the relative positions of the pistons and sleeve valve when the combustion cylinder piston has fully uncovered the exhaust port 20, at which time the pump piston is performing its upstroke, thereby forcing air through the transfer passage, which has been opened by the concurrent downward movement of the sleeve valve, thereby bringing port 13 into registry with said transfer passage.

Consequently air from the pump cylinder enters the combustion cylinder just as the latter has become exhausted to atmosphere, the cool, fresh air continuing to flow into said combustion cylinder, for heat exchange and scavenging purposes until the piston has completely closed the exhaust port in the initial portion of its up-stroke. The transfer passage has remained fully open during this operation, because its crank has been passing over the lower dead centre, and only begins to close as the piston begins its compression stroke. But, just at this point in the operation, with the exhaust port entirely closed, the transfer passage still fully open, and the pump piston about 60° from the top of its stroke, a measured quota of liquid fuel is injected through opening 21, into the pump cylinder, to blend with the air therein and be forced therewith into the combustion cylinder during the remainder of the pump piston upstroke.

It will now be appreciated that the complementary conoidal surfaces of the piston

and cylinder head, the head surface having the port 19, establish an ideal contracting space for initially mixing the fuel and air, whose stream is first forced against the roof of passage 17^a in port 19, and thence deflected to traverse said passage. It is my purpose that the stream of mixture shall be caused to have sharp impact against a number of surfaces in its course toward the combustion cylinder, so that the heavier fuel particles may become pulverized, to be more finely divided. Therefore, the passage 8 is given substantially the form shown in Fig. 1, with the bend 8^a from the horizontal to the vertical, and the lower bend 8^b into the upwardly inclined delivery portion 8^c.

The upper surface of bend 8^a enhances the mixing effect that occurs in the passage, because fuel particles bombarding the nearer points in the curved surface will, as deflected downwardly, intersect other particles whose surface impaction is delayed by the longer path they have to take in reaching the more distant segment of the arc. The same condition is true with respect to the curved surface in bend 8^b, and thus highly efficient fuel comminution and fuel and air mixing is provided in the angled passage 8. I very largely attribute the success of my motor to the fine subdivision of the fuel and its very thorough admixture with the air as the direct result of the peculiar, angled formation of the transfer passage. Attention is also directed to the fact that passage 8 is of relatively small cross-sectional area, to thereby accord a high flow rate therethrough, as a contributing factor. Further, it is to be noted that the delivery portion 8^c of passage 8 is inclined upwardly, toward one side of the cylinder head 18. The stream of gaseous mixture is thereby caused to take a path upwardly toward the cylinder head, thereby avoiding the tendency of the stream taking a short cut toward the exhaust port during that portion of the piston stroke which is performed while the exhaust port is open; also, by filling the cylinder head first, the effect, with the increase in volume, is to force downwardly, in advance, any remaining products of combustion.

The passage 8 is shut off from the pump cylinder as piston 3 completes its upstroke and sleeve 11 rises to remove port 13 from registry with said passage. This occurs when piston 4 has moved through rather more than half its compression stroke, the mixture remaining in a turbulent state while the compression is being completed.

Firing of the compressed charge is effected in the usual manner by spark plug 23.

For fuel injection purposes I provide a pump having a cylinder 24, which extends from a housing 24^a, supported as by a bracket 25 that is secured to the crank case. (See Fig. 3.) A piston 26 is reciprocable in cylinder 24, the piston rod 27 operating through a bushing 28 provided in the lower portion of cylinder 24 and having a head 27^a, with which a cam 29, carried by a cam shaft 30, co-acts. The piston 26 is held normally in and is returned to its lowermost position by means of a spring 31 that bears downwardly upon head 27^a. Power is suitably communicated from the crank shaft to rotate the cam shaft 30, the operating means here shown being a chain 32 connecting sprockets 33, 34 respectively upon the crank shaft and cam shaft. Fuel is delivered to cylinder 24 as from a tank 35, entering by means of a pipe 36, through a two-way passage 37, that opens into cylinder 24 both above and below piston 26. When the piston is in its lower position (see Fig. 3) fuel enters only above the piston, filling the cylinder space 38, but as the piston rises, to force fuel upwardly through pipe 39, for delivery into the pump cylinder 1, it thereby uncovers the lower portion of the two-way passage 37, allowing liquid fuel to be drawn therein by suction from the increasing volume and by the gravity head of the fuel. As piston 26 descends, the fuel drawn into the lower chamber is forced back into passage 37, against the gravity head in feed pipe 36, until the piston has uncovered the upper opening of passage 37, thus exposing the fuel to be acted on by the depression in cylinder 24. The quantity of liquid fuel which can be injected into the pump cylinder 1 is controlled by means of an adjustable needle valve 40, (Fig. 4) provided therefor in a boss 42 that is suitably secured to the wall of cylinder 1, said boss, at its inner portion, being recessed to receive a threaded plug 43 that is pierced with a fuel delivery orifice 44.

The boss 42 is recessed at its outer portion to receive a hollow, interiorly threaded member 45, having a head portion 46 by which it may be manipulated, said head portion engaging an arm 47 that is bifurcated at its free end 48, (Fig. 5) to receive a pin 49 carried by a control bar 50. The boss 42 is interiorly threaded in its outer recess, and the member 45 is provided with an exterior screw thread to engage therewith, so that as the member 45 is turned in either direction it will thereby regulate the extent of the clearance between the needle valve and its seat, to thus meter the quantity of liquid fuel injected during an upward stroke of plunger 26.

The capacity of fuel pump chamber 38 is in excess of the fuel charge requirement for a single injection, and therefore by-pass means are provided to return the unused quantity of liquid fuel to the fuel supply line 51. These means include an orifice 52, leading from pump chamber 38, through the wall of cylinder 24, and communicating with

a valve chamber 53, which contains a ball valve 54 that normally closes the orifice 52 under the pressure of a spring 55. A pipe 56 connects valve chamber 53 with fuel supply pipe 51. The strength of spring 55 is predetermined to permit the fuel injection to occur at a given pressure, said spring however yielding when that given pressure is exceeded, and thereby causing valve 54 to open for the by-passing of the unused fuel.

The stem 57 of needle valve 40 is threaded into the member 45, and has a knurled head 58 for manual adjustment in setting the valve, the adjustment being secured by a lock nut 59.

The control bar 50, which may have a suitable operating connection, as at 60, also has a pin 61 to engage the bifurcated end of a lever 62 which operates the throttle valve 63. Hence, the air supply and the fuel supply may be proportionally controlled in a single operation.

The throttle valve is shown as located in an air supply pipe 64 which connects with a funnel shaped device 65 that communicates with the intake port 66, aligned with passage 10, for the delivery of air to the pump cylinder 1 through sleeve port 14.

Variations within the spirit and scope of my invention are equally comprehended by the foregoing disclosure.

I claim:

1. The new method of creating a power stroke for an internal combustion cylinder, which consists in expanding to atmosphere the burnt gases of a previous power stroke, then delivering to said cylinder part of a pressure charge of air, to scavenge it, then adding liquid fuel to the remainder of said air charge, while continuing delivery thereof to the cylinder as a new explosion charge, and subjecting the air and fuel to mixing conditions during delivery.

2. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, the combination of connecting means for said cylinders provided with an angled communicating passage, a slidable valve within said pump cylinder to control said passage and means for passing fresh air and fuel mixture in succession through said passage.

3. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, said pump cylinder having greater volumetric capacity than said combustion cylinder, in combination, connecting means for said cylinders provided with an angled communicating passage, air intake means for said pump cylinder, exhaust means for said combustion cylinder, and control means for said passage operable to permit the transfer of scavenging air from the pump cylinder to the combustion cylinder while the exhaust means remain open following rejection of a burnt charge.

4. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, said pump cylinder having greater volumetric capacity than said combustion cylinder, in combination, connecting means for said cylinders provided with an angled communicating passage, air intake means for said pump cylinder, exhaust means for said combustion cylinder, control means for said passage operable to permit the transfer of scavenging air from the pump cylinder to the combustion cylinder while the exhaust means remain open following the rejection of a burnt charge, and means, timed with the closing of said exhaust means, to inject liquid fuel into the pump cylinder, so that a mixture of fuel and air may then flow through said passage into the combustion cylinder.

5. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, said pump cylinder having greater volumetric capacity than said combustion cylinder, the combination of connecting means for said cylinders provided with a communicating passage, said passage having a horizontal portion, a continuing portion which is angled relatively to said horizontal portion, and a delivery portion which is angled relatively to said continuing portion, said delivery portion being directed interiorly of the combustion cylinder toward its head, whereby said passage serves successively for the transfer to the combustion cylinder of scavenging air, and as a mixing conduit for the transfer of liquid fuel and air thereto.

6. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, said pump cylinder having greater volumetric capacity than said combustion cylinder, the combination of connecting means for said cylinders provided with a communicating passage, said passage extending horizontally through the head of the pump cylinder and opening into said cylinder through a centrally disposed port, said passage having a continuing portion which is angled relatively to said horizontal portion, and a delivery portion which is angled relatively to said continuing portion, said delivery portion being directed interiorly of the combustion cylinder toward its head, whereby said passage serves successively for the transfer to the combustion cylinder of scavenging air, and as a mixing conduit for the transfer of liquid fuel and air thereto.

7. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, said pump cylinder having greater volumetric capacity than said combustion cylinder, the combi-

nation of connecting means for said cylinders provided with a communicating passage, said passage serving as a combined transfer and mixing conduit, and presenting a succession of angled portions each bounded by curved surfaces opposed to the stream of fuel mixture for bombardment thereby, to create intersecting paths for fuel particles in said stream.

8. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, said pump cylinder having greater volumetric capacity than said combustion cylinder and having an air intake port, said combustion cylinder having an exhaust port, in combination, connecting means for said cylinders provided with a transfer passage, a ported sleeve valve within said pump cylinder to control the air intake and transfer, pistons respectively in said cylinders, the piston for the combustion cylinder controlling the exhaust port thereof, and a crank shaft, connections between said crank shaft, pistons and sleeve valve, the crank settings of the connections being so related that air is admitted to the pump cylinder at the beginning of the pump piston down stroke, while the combustion cylinder piston is performing its compression stroke, the air intake closing substantially as the pump piston begins its up stroke, the combustion cylinder piston opening the exhaust port during the up stroke of the pump piston, and the transfer passage being opened by the sleeve valve before the exhaust is closed.

9. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, said pump cylinder having greater volumetric capacity than said combustion cylinder and having an air intake port, and liquid fuel injection means, said combustion cylinder having an exhaust port, in combination, connecting means for said cylinders provided with a transfer passage, a ported sleeve valve within said pump cylinder to control the air intake and transfer, pistons respectively in said cylinders, the piston for the combustion cylinder controlling the exhaust port thereof, and a crank shaft, connections between said crank shaft, pistons and sleeve valve, the crank settings of the connections being so related that air is admitted to the pump cylinder at the beginning of the pump piston down stroke, while the combustion cylinder piston is performing its compression stroke, the air intake closing substantially as the pump piston begins its up stroke, the combustion cylinder piston opening the exhaust port during the up stroke of the pump piston, the transfer passage being opened by the sleeve valve before the exhaust is closed, and means for actuating the fuel injecting means as the combustion cylinder piston closes the exhaust port, whereafter a mixture of air and fuel is transferred to the combustion cylinder during the compression stroke of its piston.

10. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, the combination of connecting means for said cylinders provided with a transfer passage, and control means therefor whereby fresh air and fuel mixture are successively delivered to the combustion cylinder, said passage having a delivery portion which is directed toward the head of the combustion cylinder.

11. In an internal combustion engine including separate air-pump and combustion cylinders, the combination of connecting means for said cylinders provided with a transfer and mixing conduit, control means therefor whereby fresh air and fuel mixture are successively delivered to the combustion cylinder, and means for injecting liquid fuel into said pump cylinder, said conduit being angled and presenting a succession of curved surfaces opposed to the stream of fuel and air, for bombardment thereby, and to direct fuel particles into intersecting paths for admixture.

12. In an internal combustion engine including separate air-pump and combustion cylinders, said pump cylinder having greater volumetric capacity than said combustion cylinder, the combination of delayed fuel injecting means for said pump cylinder, connecting means for said cylinders provided with a transfer and mixing conduit, control means therefor adapted for the admission first of scavenging air alone into the combustion cylinder, and then for continued admission with the added fuel to provide a combustion charge.

13. In an internal combustion engine including separate air pump and combustion cylinders, pistons respectively for said cylinders, said pump cylinder having greater volumetric capacity than said combustion cylinder, the combination of delayed fuel injection means for said pump cylinder, connecting means for said cylinders provided with a transfer and mixing conduit, and control means therefor adapted for the admission first of scavenging air alone into the combustion cylinder, and then for continued admission with the added fuel to provide a combustible charge, all during a single stroke of the combustion cylinder piston.

14. In an internal combustion engine including separate air-pump and combustion cylinders arranged side by side and pistons respectively therefor, the pump piston having a conical surface, in combination, means for injecting liquid fuel into said pump cylinder, connecting means for said cylinders provided with a transfer conduit, the

pump cylinder head having a conical inner surface and a passage adapted to co-act with said transfer conduit, and control means for said conduit, whereby fresh air and fuel mixture are successively delivered to the combustion cylinder, the conicity of the pump-piston and cylinder head surfaces co-acting to direct the charge toward the opening for the passage in the pump cylinder head.

15. An internal combustion engine including a pump cylinder having a piston, said cylinder having a delivery port disposed centrally in its head, the inner surface of the cylinder head and the opposed surface of the piston having complementary conoidal form, to centre the charge toward said port.

16. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, the combination of connecting means for said cylinders provided with a transfer passage control means therefor, said pump cylinder having an air intake passage through its head, control means therefor, and constricted means for delivering air to said intake passage.

17. In an internal combustion engine including separate air-pump and combustion cylinders provided with transfer means, the combination of a liquid fuel pump, means of communication between said fuel pump and air-pump cylinder, actuating means for said fuel pump, and means for metering the liquid fuel charges injected by said fuel pump.

18. In an internal combustion engine including separate air-pump and combustion cylinders provided with transfer means, the combination of separate air supply means and liquid fuel supply means for said air-pump cylinder, respective control means for said air and fuel supplies, and common means for actuating said controls.

19. An internal combustion engine having a cylinder provided with an indirect intake passage, and means for successively delivering fresh air and fuel mixture to said cylinder through said passage.

20. An internal combustion engine having a cylinder provided with an indirect intake passage, and means for successively delivering fresh air and fuel mixture to said cylinder through said passage, said passage presenting an impaction surface opposed to fluid flow.

21. An internal combustion engine having a cylinder and a piston therein, said cylinder provided with a passage opening thereinto nearly midway of the piston stroke, and means for successively delivering fresh air and fuel mixture through said passage.

22. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, the combination of connecting means for said cylinders provided with a connecting passage, a valve to control said passage, and means for passing fresh air and fuel mixture in succession through said passage.

23. In an internal combustion engine including separate pump and combustion cylinders arranged side by side, the combination of connecting means for said cylinders provided with an angled connecting passage, a valve to control said passage and means for passing fresh air and fuel mixture in succession through said passage.

Executed the 21st day of April, 1924.

CHARLES J. WEGER.