No. 820,222. PATENTED MAY 8, 1906.

D McR. LIVINGSTON.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAY 12, 1904.

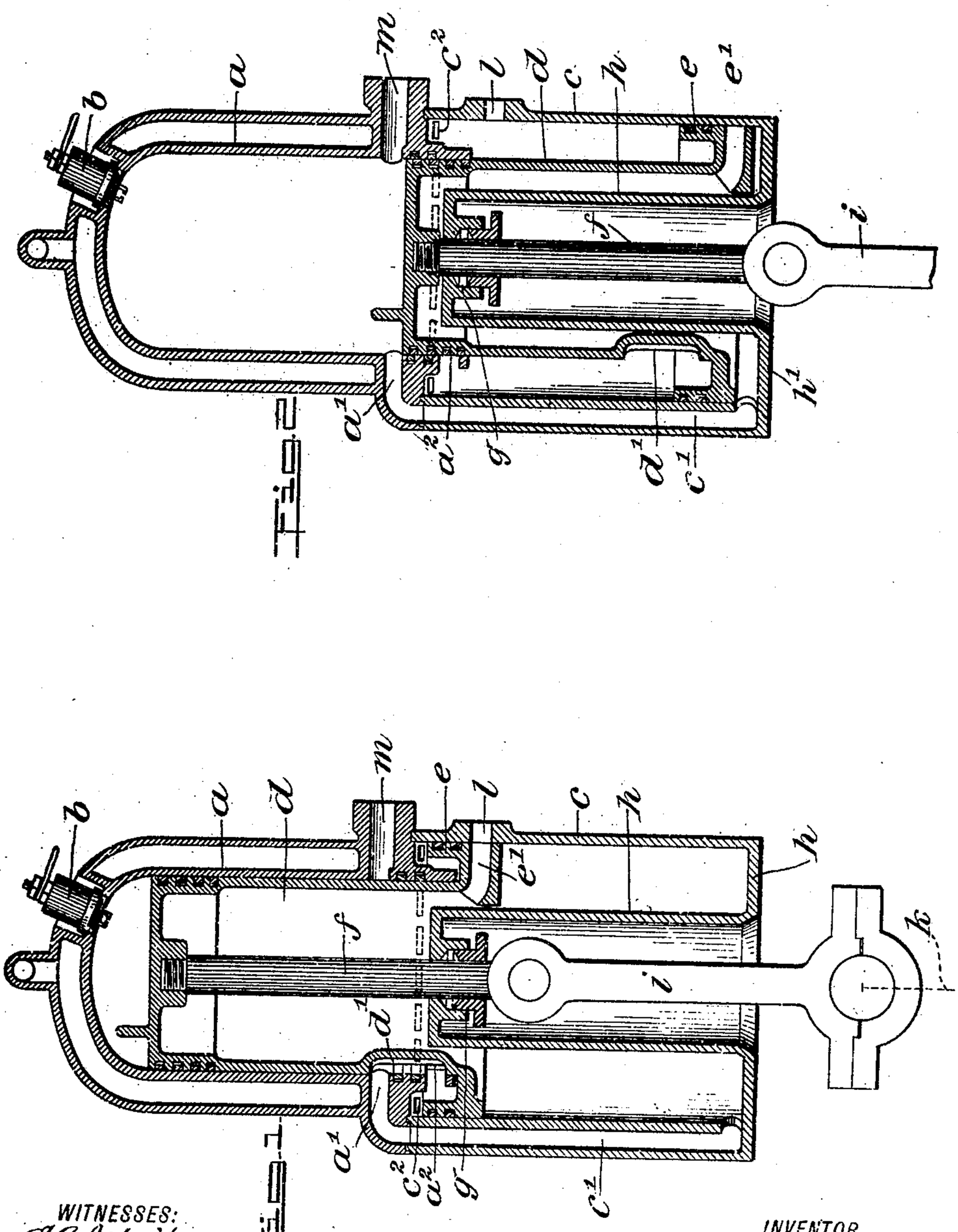

Fig. 2.

Fig. 1.

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INTERNAL-COMBUSTION ENGINE.

No. 820,222. Specification of Letters Patent. Patented May 8, 1906.

Application filed May 12, 1904. Serial No. 207,531.

To all whom it may concern:

Be it known that I, D. McRa Livingston, a citizen of the United States, and a resident of the city of New York, borough of Manhattan, in the county and State of New York, have invented a new and Improved Internal-Combustion Engine, of which the following is a full, clear, and exact description.

The invention relates to a two-cycle internal-combustion engine.

The object of the invention is to provide a valveless engine in the cycle of which there will be maintained a stratification of scavenging-air and fuel, so that after each explosion a volume of scavenging-air will be blown through the cylinder, cooling and cleansing the same, and will be followed by the fuel charge, which will then be compressed and ignited in the usual or any desired manner. I attain this end by certain novel features of construction and organization, which will be fully set forth hereinafter and in which my invention resides, as will be pointed out in the claims.

Reference is had to the accompanying drawings, which represent an example of the practical embodiment of my inventive idea, in which drawings like reference characters indicate like parts in both the views and in which—

Figure 1 is a longitudinal section of the engine, showing the piston in the position which it assumes immediately before or upon ignition; and Fig. 2 is a similar section, excepting that the piston is shown at the end of its power-stroke.

a indicates a power-cylinder which may be water-jacketed, if desired, and fitted with an ignition device—for instance, a spark-plug, such as *b*.

c indicates a compressor-cylinder which is located at the outer end of the power-cylinder, and which preferably is of larger diameter than said cylinder. Working in the power-cylinder *a* is a trunk-piston *d*, having at its outer or lower extremity an enlargement *e*, forming part of the compressor-piston surface and working in the compressor-cylinder *c*. A rod *f* is joined to the head of the piston *d* and passes through a stuffing-box and gland *g*, formed on the top of the dome or trunk *h*. The dome or trunk *h* is provided to reduce the contents of the compressor-cylinder *c* and also to assist in maintaining the stratification of this scavenger-air and fuel mixture, as will fully appear hereinafter. As here shown, formed integral with the compressor-cylinder is a web *h'* at the base of said cylinder, joining the cylinder and its internal dome. The inner end surface of the piston *d* receives the action of the gases of combustion in the usual manner, and the hollow interior surfaces and the outer surface of the enlargement *e* of the piston constitute the compressor-piston surfaces. The dome *h* and web *h'* form, as it will be observed, part of the walls of the compressor-cylinder, giving the cylinder an annular cross-sectional form, and the hollow piston when in its outer position, as in Fig. 2, incloses the dome *h*, the compressed gases then lying between the interior walls of the hollow piston of the enlargement *e* and the web *h'*, dome *h*, and lower extremity of the cylinder *c*. A connecting-rod *i* is joined to the piston-rod *f* and to a crank (not shown) in any desired manner. In Fig. 1 the dotted line *k* indicates the crank radius, which is adapted to the illustrated proportions of the cylinders and pistons.

l indicates an orifice in the upper portion of the compressor-cylinder, which is adapted to be placed in communication with the source of the combustible mixture constituting the fuel for the engine. In the piston enlargement *e* is formed a port *e'*, which is adapted to register with the port or orifice *l*, and which at its inner end is drawn upward slightly, so as to guide the entering gases upward into the upper part of the hollow piston *d*. It will be observed that the registry of the parts *l* and *e'* occurs only when the piston is in its upper or inner position and that the instant the piston begins its downward movement the port *e'* passes out of registry with the port *l*. In the walls of the compressor-cylinder *e* is formed a transfer-passage *c'*, communicating with the compressor-cylinder at its base and leading to the inlet-port *a'* of the power-cylinder. The piston *d* is provided with a port *d'*, which when the piston is in its uppermost position is adapted to register with the inlet-port *a'* and with a port a^2 in the lower extremity of the power-cylinder *a*. The upper extremity of the compressor-cylinder *c* is formed with a port or ports c^2, communicating directly with the atmosphere, and when the piston *d* is in its uppermost position the port *d'* establishes communication between the ports *a'* and c^2, the port a^2 in the lower extremity of the cylinder *a* permitting this communication.

m indicates the exhaust-port, which leads from the base of the cylinder *a* and is located

slightly above the inlet-port a', so that as the piston reaches its outermost position the exhaust-port is uncovered an instant before the inlet-port.

The operation of the engine may be traced as follows: Assuming the parts to be in the position shown in Fig. 2, upon an inward movement of the piston the port a' will be covered and the air in the hollow piston d will be rarefied, so that the instant the parts reassume the position shown in Fig. 1 a charge of the fuel mixture will be drawn into the hollow piston d through the registering ports l and e' and a volume of atmospheric air will simultaneously rush into the lower part of the compressor-cylinder c through the ports c^2, a^2, d', a', and c'. In connection with this operation it will be observed that the fuel mixture is directed into the hollow piston d, while the scavenging-air is directed into the compressor-cylinder c, thus establishing a stratification of the air and fuel mixture, which stratification, as will hereinafter appear, is maintained throughout the cycle. Upon the following downstroke of the piston the stratified air and combustible mixture will be compressed, and when the pistons reach the position shown in Fig. 2 the scavenging-air lying nearer to the port a' than the mixture will pass into the cylinder, scavenging and cooling the same, and it will be followed by the combustible mixture. Upon the following upstroke of the piston the ports a' and m are closed and the mixture will be compressed, and when the position shown in Fig. 1 is nearly reached the mixture will be ignited, expanded, and at the end of the power-stroke exhausted through the port m in the usual manner. After the power-stroke the above-described entry of the scavenging-air and mixture is repeated in the order explained, and so on throughout the operation of the engine. In this connection it will be observed that a small volume of the mixture will remain in the port c' and the hollow piston d. This small volume of mixture, however, is forced up into the position when the parts assume the position shown in Fig. 1 by reason of the location of the air-supply port c', which introducing the atmospheric air at the base of the compressor-cylinder allows the advancing body of this air to push before it the small quantity of the mixture which may lie in the compressor-cylinder. It will also appear that since the fuel mixture is directed upward into the hollow piston by the disposition of the port e' and the scavenger-air is discharged into the lower part of the compressor-cylinder the upper part of the dome h, in its peculiar position with respect to the piston, will act to effect a division between these two gases, which will be undisturbed by the subsequent compressive action of the piston. Consequently a true stratification of the scavenging-air and the mixture is constantly maintained in a two-cycle engine without the use of valves of any sort. The advantage of this arrangement will be apparent to persons skilled in the art.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. An internal-combustion engine having a power cylinder and piston and means forming a compressor communicating with the power-cylinder and operating in unison with the power-piston, said compressor having ports leading into the compressor-chamber at opposite points therein and respectively serving to introduce the combustible mixture and scavenger-air whereby to maintain said elements in stratification in the compressor-chamber and to discharge said elements in said relation to the power-cylinder.

2. An internal-combustion engine having a power cylinder and piston, a compressor including a piston-like part carried by said piston, and means comprising valveless registering ports for introducing scavenger-air into one portion of the compressor and a combustible mixture into the other portion and for successively leading the scavenger-air and fuel mixture to the power-cylinder.

3. An internal-combustion engine having a power cylinder and piston, a compressor-cylinder forming an enlarged continuation of the power-cylinder, the power-piston having an enlarged portion forming a compressor-piston, and means for introducing scavenger-air into one portion of the compressor-cylinder and a combustible mixture into the other portion of the compressor-cylinder and for successively leading the scavenger-air and combustible mixture to the power-cylinder, said means comprising valveless registering ports in several of the engine parts.

4. An internal-combustion engine having a power cylinder and piston, a compressor-cylinder forming an enlarged continuation of the power-cylinder, the power-piston having an enlarged portion forming a compressor-piston, and means for introducing scavenger-air into one portion of the compressor-cylinder and a combustible mixture into the other portion of the compressor-cylinder and for successively leading the scavenger-air and combustible mixture to the power-cylinder, the power-piston being hollow and the compressor-cylinder having an internal dome covered by the hollow piston when at the limit of the power-stroke.

5. An internal-combustion engine having a power-cylinder and a hollow power-piston, a compressor-cylinder forming a continuation of the power-cylinder, the power-piston working in the compressor-cylinder and forming therewith a compressor, an internal dome in the compressor-cylinder covered by the hollow power-piston when at the limit of its stroke, and means for introducing strata of

combustible mixture and scavenger-air into said compressor-cylinder and for controlling the movement of said mixture and air to the power-cylinder.

6. An internal-combustion engine having a power-cylinder and a hollow piston, a compressor-cylinder forming a continuation of the power-cylinder, the power-piston working in the compressor-cylinder and forming therewith a compressor, an internal dome in the compressor-cylinder covered by the hollow piston when at the limit of its power-stroke, and means for controlling the gas movement in the engine, said means including devices for introducing scavenger-air into one portion of the compressor and a combustible mixture into the other and for successively leading the scavenger-air and combustible mixture into the power-cylinder.

7. An internal-combustion engine having a power-cylinder and a hollow piston, a compressor-cylinder forming a continuation of the power-cylinder, the power-piston working in the compressor-cylinder and forming therewith a compressor, an internal dome in the compressor-cylinder covered by the hollow piston when at the limit of its power-stroke, and means for controlling the gas movement in the engine, said means including valveless registering ports in several of the parts, for introducing scavenger-air into one portion of the compressor and a combustible mixture into the other portion of the compressor and for successively leading the scavenger-air and combustible mixture to the power-cylinder.

8. An internal-combustion engine having a power-cylinder with an inlet and an exhaust port, a hollow trunk power-piston having an enlargement at its lower portion forming a compressor-piston, the power-piston having a scavenger-air port at its lower portion and the compressor-piston having a combustible-mixture port leading upward into the hollow power-piston, and a compressor-cylinder in which the compressor-piston operates, the compressor-cylinder having a combustible-mixture port adapted to register with the combustible-mixture port of the compressor-piston, the compressor-cylinder also having a transfer-port running to the power-cylinder-inlet port and adapted to be connected through the medium of the said inlet-port and the scavenger-air port of the power-piston with the upper part of the compressor-cylinder above the compressor-piston, and the compressor-cylinder having atmospheric communication above the compressor-piston.

9. An internal-combustion engine having a power-cylinder with an inlet and an exhaust port, a hollow trunk power-piston having an enlargement at its lower portion forming a compressor-piston, the power-piston having a scavenger-air port at its lower portion and the compressor-piston having a combustible-mixture port leading upward into the hollow power-piston, and a compressor-cylinder in which the compressor-piston operates, the compressor-cylinder having a combustible-mixture port adapted to register with the combustible-mixture port of the compressor-piston, the compressor-cylinder also having a transfer-port running to the power-cylinder-inlet port and adapted to be connected through the medium of the said inlet-port and the scavenger-air port of the power-piston with the upper part of the compressor-cylinder above the compressor-piston and the compressor-cylinder having atmospheric communication above the compressor-piston, and an internal dome in the compressor-cylinder and adapted to be covered by the hollow power-piston when at the limit of its power-stroke.

10. An internal-combustion engine, having a power cylinder and piston, a compressor acting in unison with the power-piston, and means comprising valveless registering ports for introducing scavenger-air into one portion of the compressor, and a combustible mixture into another portion of the compressor, and for successively leading the scavenger-air and combustible mixture to the power-cylinder.

11. An internal-combustion engine having a power cylinder and piston, a compressor acting in unison with the power-piston, and means comprising valveless registering ports for introducing stratified scavenger-air and combustible mixture into the compressor, and for leading the said mixture and air in said strata to the power-cylinder.

12. An internal-combustion engine having a power or working cylinder with an enlarged compressor-cylinder at the outer end thereof, a hollow piston of two diameters operating respectively within the power and compressor cylinders, a dome projecting into the compressor-cylinder and adapted to be inclosed by the piston when in its outer position, and means comprising valveless registering ports for introducing scavenger-air into the compressor-cylinder and a combustible mixture into the hollow piston when the piston is in its inner position, and for leading said air and combustible mixture successively into the power-cylinder when the piston is in its outer position.

13. An internal-combustion engine having a power-cylinder, a compressor-cylinder at the outer end thereof, a hollow piston of two diameters operating respectively in the power and compressor cylinders, a dome projecting into the compressor-cylinder and adapted to be inclosed by the piston when at its outer position, and means comprising valveless registering ports for introducing stratified scavenger-air and combustible mixture into the compressor-cylinder and hollow piston, and for leading said mixture of air in said strata to the power-cylinder.

14. An internal-combustion engine having a power-cylinder, a compressor-cylinder at the outer end thereof, a hollow piston of two diameters operating respectively in the power and compressor cylinders, a dome projecting into the compressor-cylinder and adapted to be inclosed by the piston when at its outer position, means comprising valveless registering ports for introducing stratified scavenger-air and combustible mixture into the compressor-cylinder and hollow piston, and for leading said mixture of air in said strata to the power-cylinder, a piston-rod connected to the piston and extending through the inner end of the dome, and a connecting-rod joined to the piston-rod and operating within the said dome.

15. An internal-combustion engine having a power or working cylinder with an enlarged compressor-cylinder at the outer end thereof, a hollow piston of two diameters operating respectively within the power and compressor cylinders, a dome projecting into the compressor-cylinder and adapted to be inclosed by the piston when in its outer position, means comprising valveless registering ports for introducing scavenger-air into the compressor-cylinder and a combustible mixture into the hollow piston when the piston is in its inner position, and for leading said air and combustible mixture successively into the power-cylinder when the piston is in its outer position, a piston-rod attached to the piston and extending through the inner end of the dome, and a connecting-rod attached to the piston-rod and operating within the dome.

16. An internal-combustion engine having a power cylinder and piston, a compressor acting in unison with the power-cylinder, and means comprising valveless registering ports for introducing stratified scavenger-air and a mixture of fuel and air into the compressor and for leading said scavenger-air and said mixture when compressed directly from the compressor into the power-cylinder.

17. An internal-combustion engine having a working or power cylinder with an enlarged continuation forming a compressor-cylinder, a hollow piston operating in the working cylinder and having an enlarged portion operating in said compressor-cylinder, and means comprising valveless registering ports for introducing a combustible mixture into the hollow piston and a volume of scavenger-air into the compressor-cylinder, and for leading said air and combustible mixture in successive strata into the working cylinder, the engine having an exhaust-port arranged to permit the escape of said scavenger-air after performing its function in the working cylinder and before the ignition of the working charge.

18. An internal-combustion engine having a power cylinder and piston, a compressor acting in unison with the power-cylinder, and means comprising valveless registering ports for introducing stratified scavenger-air and a mixture of air and fuel into the compressor and for leading said scavenger-air and said mixture when compressed directly from the compressor into the power-cylinder, said cylinder having an exhaust-port arranged to permit the escape of said scavenger-air after performing its function in the working cylinder, and before the ignition of the working charge.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

D. McRA LIVINGSTON.

Witnesses:
ISAAC B. OWENS,
JNO. M. RITTER.