

A. A. NEFF.
INTERNAL COMBUSTION ENGINE CONSTRUCTION.
APPLICATION FILED MAY 28, 1915.

Patented Mar. 11, 1919.
3 SHEETS—SHEET 1.

1,296,686.

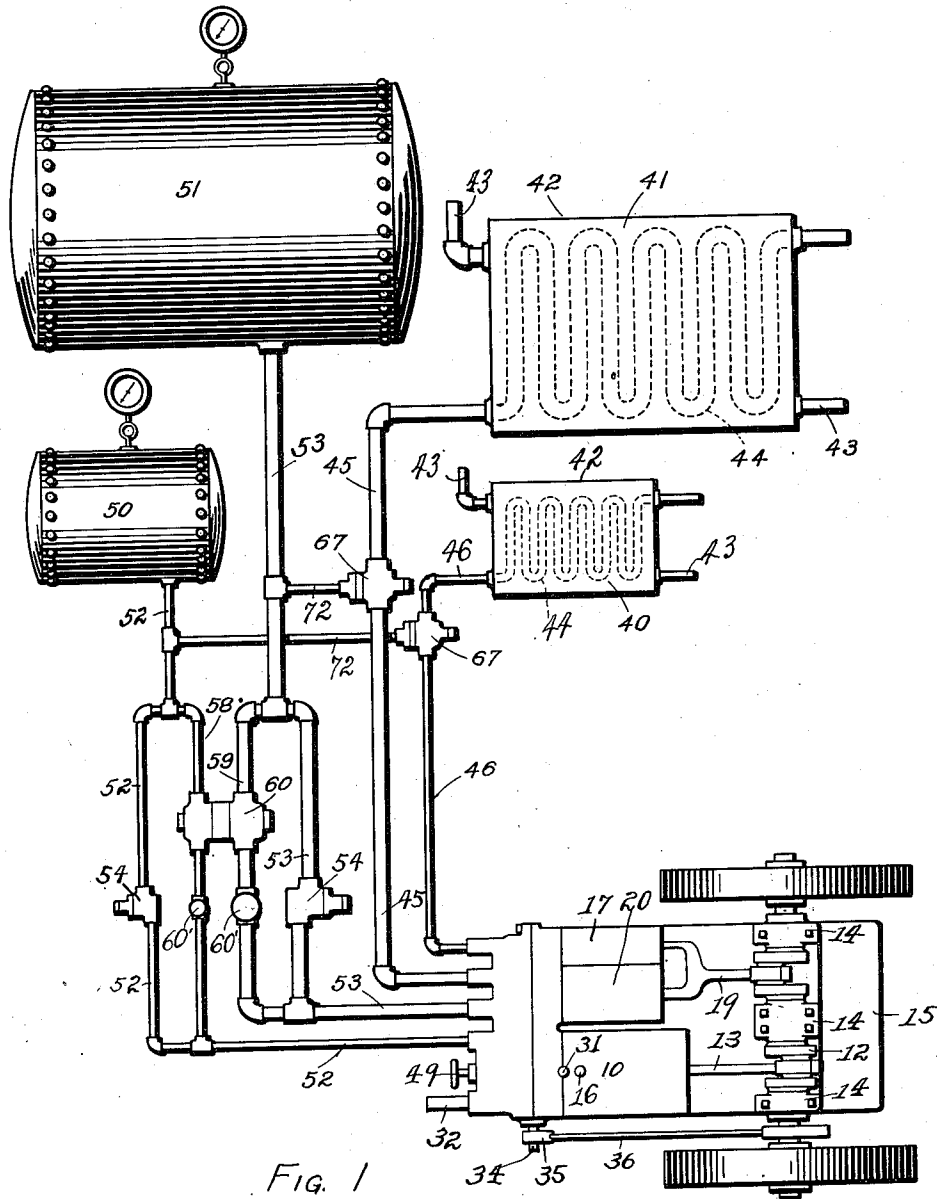


FIG. 1

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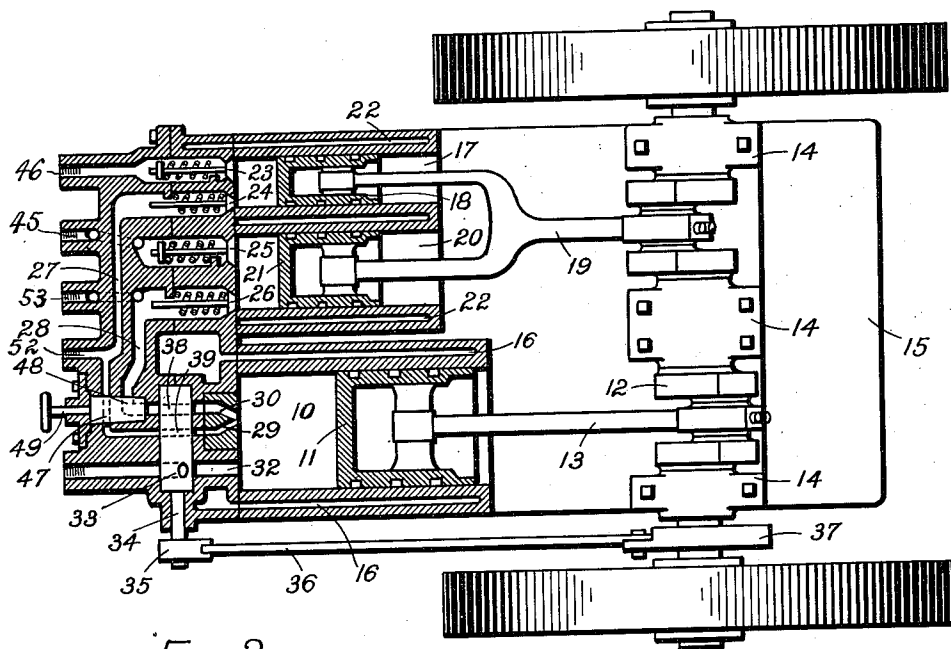


Fig. 2

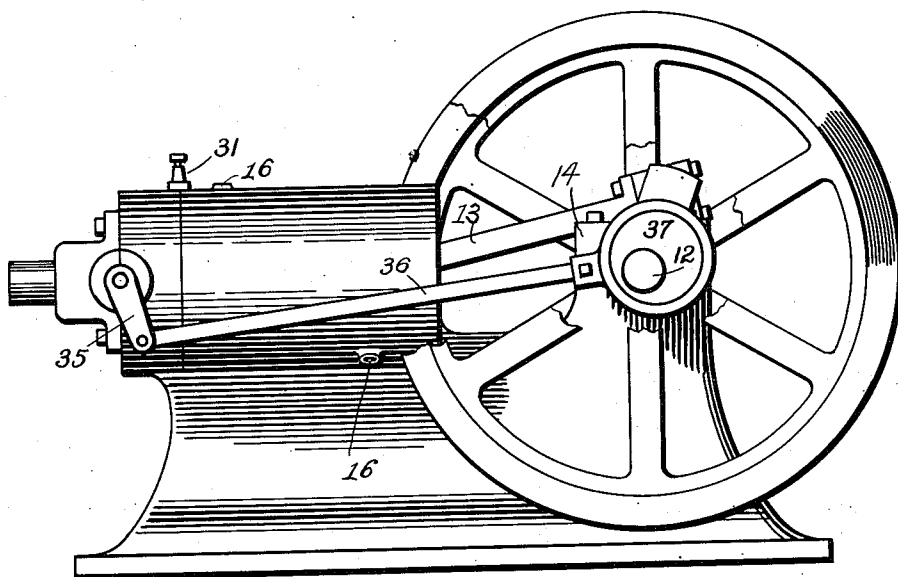


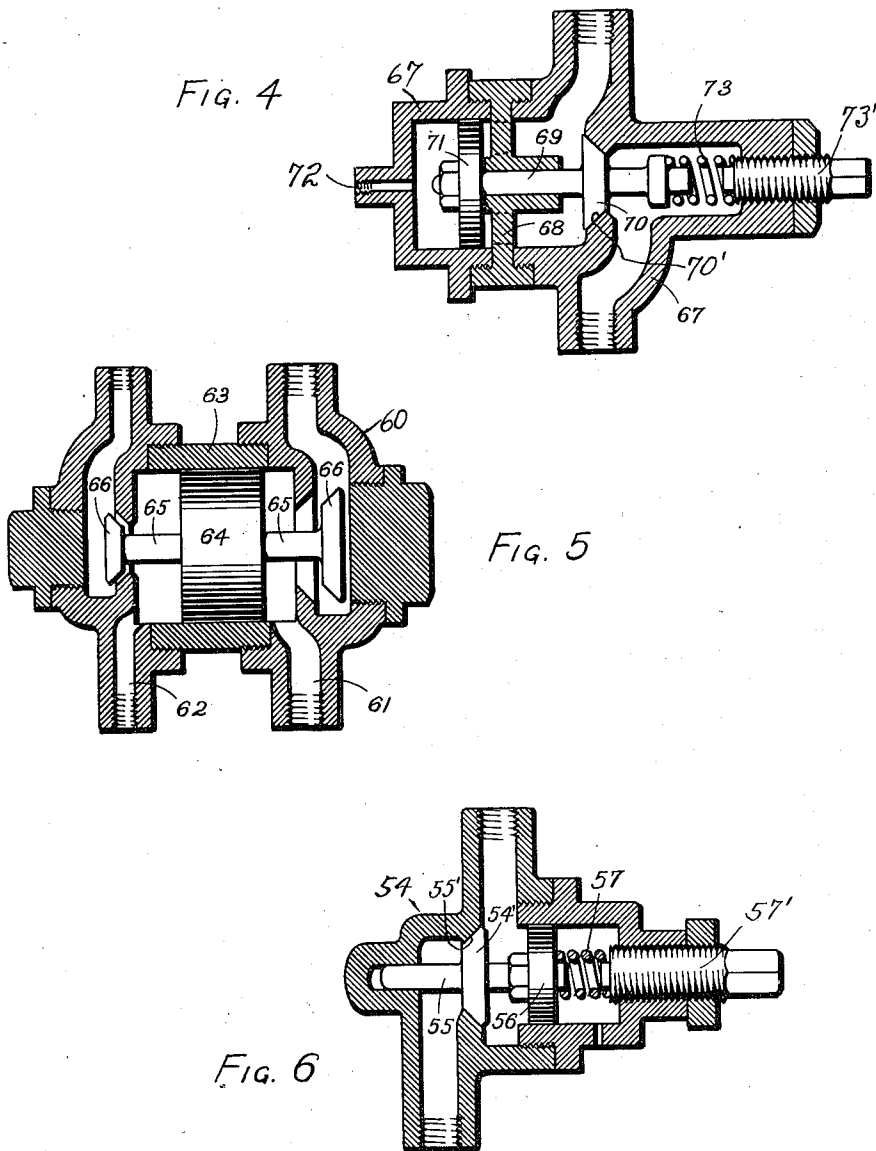
Fig. 3

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INTERNAL-COMBUSTION-ENGINE CONSTRUCTION.

1,296,686.

Specification of Letters Patent.

Patented Mar. 11, 1919.

Application filed May 28, 1915. Serial No. 30,891.

To all whom it may concern:

Be it known that I, ADOLPH ANTON NEFF, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented Internal-Combustion-Engine Constructions, of which the following is a specification.

My invention relates to internal combustion engine constructions and has for its object the provision of a simple, improved construction of this character adapted to produce a very high degree of efficiency. Other objects will appear hereinafter.

The invention consists in substantially the combinations and arrangement of parts hereinafter described, shown in the accompanying drawings forming a part of this specification, and more specifically set forth in the subjoined claims.

In the drawings—

Figure 1 is a plan view of an internal combustion engine construction embodying my invention and shown diagrammatically.

Fig. 2 is a top view of an internal combustion engine with portions broken away showing internal parts.

Fig. 3 is a side elevation with portions broken away to show hidden parts.

Fig. 4 is an enlarged detail section of a valve used in the construction.

Fig. 5 is a similar view of another valve used in the construction; and

Fig. 6 is a similar view showing still another valve used in the construction.

In embodying my invention in practice, I preferably provide a construction in which the fuel and air, or other oxidizing agent, are reduced in temperature as low as practical and delivered to the combustion chamber of the engine under compression. The fuel and oxidizing agent are compressed isothermally as far as can be conveniently done, such as by water-jacketing the compressor or in some other convenient manner. The remaining portion of the compression is accomplished substantially adiabatically since the temperature rises so rapidly that the heat of compression cannot be transmitted to the water in the cooling means during this portion of the compression stroke.

The fuel, which may be any suitable gaseous, liquid or finely pulverized solid materials, and the air or other oxidizing agent, are preferably compressed separately and

mixed together upon their introduction into the combustion chamber. By this means I am enabled to burn the combustible mixture as it enters the combustion chamber and over a considerable period of the working stroke of the piston. I preferably cool the working cylinder as little as is necessary to insure lubrication of the working piston in order to render the combustion and exhaust strokes as nearly adiabatic as is possible, to get the greatest thermal efficiency from the fuel charge.

By compressing the fuel and air outside of the working cylinder, I am enabled to cause the cooling means, such as the circulation of water, to cool the fuel and air during compression, to a considerable degree. This could not be accomplished where the fuel and air were compressed in the working cylinder and maintain the working cylinder at a high temperature as is found to be economical in practice.

Referring more particularly to the drawings, I provide a working cylinder 10, having a working piston 11, connected to a crank shaft 12 by means of a connecting rod 13. The crank shaft 12 is mounted in suitable bearings 14 carried on the frame 15 of the engine. I provide a water-jacket 16 on large sizes of engine constructions embodying my invention, since it is found that larger sizes of engines heat more rapidly than the smaller sizes of engines. In small sizes of engines the water-jacket may be dispensed with. It is desired to provide sufficient circulation for water in the water-jacket 16 to cool the cylinder only sufficiently to prevent sticking of the piston 11 in the cylinder 10.

For convenience I have indicated the air and fuel compressors as mounted on the engine base 15 and connected to the crank shaft 12, but when so desired, these compressors may be mounted in any other convenient or desired positions and operated in any convenient or desired manner. In the form I have shown, a fuel compressor cylinder 17 is provided with a piston 18 which is connected by means of a bifurcated connecting link 19 to the crank shaft 12, see particularly Fig. 2. I also provide an air compressor cylinder 20 having a piston 21 mounted therein and connected to the other arm of the bifurcated connecting link 19. When so desired, the pistons 18 and 21 may be connected to the crank shaft 12 in any

other desired manner. The cylinders 17 and 20 are provided with a water-jacket 22 independent of the water-jacket 16 around the cylinder 10. It is desired that the circulation of water or other cooling medium through water jacket 22 have a greater velocity in order to cause greater cooling of the cylinders 17 and 20 than of the cylinder 10. The cylinder 17 is provided with a spring pressed intake valve 23 and a spring pressed discharge valve 24 in its intake and discharge ports. The cylinder 20 is provided with a spring pressed intake valve 25 and a spring pressed exhaust valve 26 in its intake and exhaust ports respectively. The exhaust ports of cylinders 17 and 20 are connected, by means of passages 27 and 28, with the cylinder 10. The ends 29 and 30 of the passages 27 and 28 respectively, are disposed at an acute angle to each other, or directed toward a common point within the cylinder 10, so that air and fuel passing through the passage ends 29 and 30 will be forced against each other in such a manner as to cause the air and fuel to become intimately mixed upon entering the cylinder.

The piston 11 is mounted in cylinder 10 in such a manner that when it is next the closed end of cylinder 10, its surface adjacent such cylinder end, is very close to the latter. This provides means whereby scavenging of the engine is very completely accomplished. The space between the piston 11 and the closed end of cylinder 10 need be only sufficient to prevent the piston head from contacting the closed end of the cylinder.

Fitted in the cylinder wall of cylinder 10, is a spark plug 31 of any convenient or desired design adapted to ignite the mixture of air and fuel upon their entry to the cylinder 10. I have not shown the wiring diagram of the electric circuit employed to produce a spark in the spark plug 31, since such circuits are common and well known in this art.

In the closed end of cylinder 10, I provide an exhaust port 32 leading to the outside atmosphere. The exhaust port 32 is controlled by a valve 33. Said valve is provided with a stem 34 operated through a crank 35, connecting rod 36, and eccentric 37, said eccentric being secured on one end of crank shaft 12. The valve stem 34 also carries valves 38 and 39 which control the passage of air and fuel through passages 28 and 27 respectively. With this arrangement then, it will be noted that the valves controlling the supply of air and fuel to the cylinder and exhaust port are automatically operated by the crank shaft of the engine. These valves 33, 38 and 39 are preferably timed so that the valves 38 and 39 open at or near the time when the piston head 11 is nearest the closed end of cylinder 10 and continue to remain open through a considerable portion of the out-

ward stroke of the piston head 11. The valves 38 and 39 are then closed during the remainder of the outward stroke of the piston head, permitting force to be applied to the piston head 11 through expansion of the gases in the cylinder 10. At or near the end of the outward stroke of the piston 11, the exhaust port 32 is opened and continues to remain open during the entire inward stroke of the piston 11, thereby causing complete scavenging of the cylinder 10. From this construction it will also be noted that a working charge is introduced to the cylinder 10 upon each outward stroke of the piston 11, causing a working impulse on the piston 11 during this stroke, and that the burnt gases are entirely removed during the return or inward stroke of the piston head. This is made possible since the air and fuel are compressed outside of the cylinder 10 and supplied thereto under sufficient compression.

The pistons 18 and 21 are timed so that they lead the piston 11 several degrees on the crank shaft in order to provide sufficient compression of the air and fuel to cause such air and fuel to enter the cylinder 10 with sufficient force to cause intimate mixing thereof as soon as valves 38 and 39 have been opened.

In order to supply the fuel and air to the compressors at as low a degree of temperature as possible, I provide coolers 40 and 41. These coolers are similar in construction and design. In each a shell 42 is provided with ingress and egress water openings 43 in order to provide means for passing the water through such shell. Also in each of the coolers is a coil 44 adapted to increase the cooling surface of the pipes conducting air and fuel through such cooler. The cooler 41 is connected to the air compressor by means of a pipe 45, and cooler 40 is connected with the fuel compressor by means of a pipe 46, so that all of the air and fuel taken by the air and fuel compressors are forced to pass through the coolers 40 and 41. This provides means whereby the air and fuel enter the compressors at comparatively low temperatures, thereby preventing the heat of compression from raising the temperature of the fuel and air to very high degrees during compression thereof. This also provides means whereby the temperatures of the compressed air and fluid are supplied to the working cylinder at lower degrees than if the coolers were not employed.

In passages 27 and 28, I provide throttle valve openings 47 and 48 in a stem 49. The stem 49 is adapted to be operated manually to control the supply of air and fuel through said openings to the cylinder 10 in order to control the speed of the engine. When the engine is throttled down, the air and fuel compressors tend to supply more fuel and air than can be forced through such throttle

valve openings into the working cylinder. I have therefore provided storage tanks 50 and 51 connected to the passages 27 and 28 by means of pipes 52 and 53. It will be seen that the storage tanks 50 and 51 provide means for supplying compressed air and fuel for the purpose of starting the engine, and also for supplying air and fuel quickly should a sudden demand be made upon them in the running of the engine.

In each of pipes 52 and 53, I provide a novel form of check valve 54, which permits the flow of fuel and air to the tanks 50 and 51 but prevents the return of such fuel and air from the tanks. A detail of valve 54 is shown in Fig. 6 and comprises a casing in which is the valve proper 54', coöperating with a valve seat 55' and carried on a valve stem 55. The valve stem also carries a piston 56 which is of substantially the same diameter as valve 54', so that back pressure on the valve from the storage tank will not tend to hold the valve closed. The valve 54' is held against its seat by a compression spring 57 and the tension of the spring may be varied by an adjusting screw 57' threaded in the casing. Owing to the balancing effect of the back pressure from the storage tank on valves 54' and piston 56', such back pressure will not tend to hold the valve 54' closed upon the beginning of admission of fluid through the valve.

To permit the fuel and air to pass from the storage tanks back to passages 27 and 28, I provide short pipes 58 and 59 forming by-passes around the check valves 54. In these by-passes I provide an equalizing valve 60, shown in detail in Fig. 5. The valve 60 comprises a casing having two passages 61 and 62, one passage adapted for the passage of air and the other for the passage of fuel. In the body of the valve is a cylinder 63 which connects the passages 61 and 62 and in the cylinder is provided a piston 64 which separates the fuel and air. The piston 64 carries valve stems 65 and on the ends of said valve stems are valves 66. The arrangement is such that when the pressures of air and fuel are equal the piston 64 remains substantially central of the cylinder 63, and maintains both valves 66 open, permitting the passage of both air and fuel. If, however, either the air or fuel should have greater pressure than the other, the side having the greater pressure would move piston 64 and consequently close the valve in the fluid having the higher pressure. The running of the engine, however, would continue to draw on the fluids and reduce the pressure on the side of piston 64 next the fluid having the higher pressure, and permit the other fluid to move the piston 64 to open the closed valve, thus causing the valve in the fluid having the greater pressure to be opened and closed rapidly to retard the flow

of such fluid to the engine in the proper quantity. The by-pass pipes 58 and 59 are each provided with a conventional check valve 60' which prevents the pressure from the compressors acting on valve 60 while the storage tanks are being charged. In each of the pipes 45 and 46 I provide a controlling valve 67 adapted to cut off the supply of fuel and air to the compressors when the pressures of such fluid and air have reached a predetermined pressure in such tanks, thereby preventing further admission of fuel and air to the tanks. A detail of the controlling valve 67 is shown in Fig. 4 and comprises a casing having a web or spider 68 mounted therein with a bearing at its axis in which is slidably mounted a valve stem 69. The valve stem carries a valve 70 adapted to coöperate with a valve seat 70' on one side of the web 68 and a piston 71 on the other side of said web. The valve 70 is normally held open by a compression spring 73. Threaded in the casing is an adjusting screw 73' engaging the spring 73 and adapted to vary the tension of said spring. The end of the casing is connected by means of a pipe 72 with one of the pipes 52 and 53, as clearly indicated in Fig. 1, so that when the pressure in one of the storage tanks is greater than the strength of spring 73, fluid from such storage tank will pass through one of the pipes 72 and move the piston 71 against the influence of the spring 73 and close valve 70, thereby cutting off the admission of fuel and air to the compressors. This provides means whereby the pressure of storage tanks 50 and 51 cannot exceed a predetermined pressure, and prevents bursting of the tanks.

It will be apparent to those skilled in the art to which this invention belongs, that more than one set of openings 29 and 30 may be provided in cylinder 10, and that the relative directions of these openings may be altered from that shown, the essential feature being that the openings 29 and 30 be situated with respect to each other so that an intimate mixture of fuel and air will be accomplished upon the latter entering the cylinder.

It will be found that this engine construction is also capable of use as an expansion engine where no internal combustion takes place. In this latter case, superheated steam or other heated fluid may be introduced into the cylinder 10 through opening 29 in the place of fuel and mixed with the air from opening 30 to give the desired results. In this case heat will be absorbed by the air causing the latter to expand to operate the engine. The engine is, however, more efficient as an internal combustion engine than a simple expansion engine. In either case, whether the engine is used as an internal combustion engine or a heat expansion

engine, it will be found that at the end of the expansion or exhaust stroke the pressure and temperature of the exhausted or expanded fluids will be very near the temperature and pressure of the atmosphere, thereby eliminating to a very great extent, the noise of the exhaust or expansion fluid leaving the cylinder. It will also be noted that since the air and fluid are intimately mixed upon entering the cylinder, and there ignited, perfect combustion will result, even though the air is admitted in excess of the amount required to support combustion, and that in case more air is admitted than is necessary for supporting combustion, this air will be heated by the heat of combustion and increased in pressure or volume to assist in the operation of the engine.

While I have illustrated and described the preferred form of construction of my invention, I do not desire to be limited to the precise details set forth, but desire to avail myself of such variations and changes as come within the scope of the appended claims.

What I claim is:

1. An internal combustion engine comprising a work cylinder having separate fuel and air passages opening thereinto, said passages meeting at an acute angle approximately at the point where they enter the cylinder and adapted to direct the fuel and air together as they enter the cylinder; sources of fuel and air supplies connected with said passages; and ignition means adjacent the point where the air and fuel passages meet adapted to ignite the fuel and air at substantially their meeting point.

2. An internal combustion engine comprising a working cylinder having separate fuel and air passages opening thereinto, said passages meeting at an acute angle approximately at the point where they enter the cylinder and adapted to cause the air and fuel to impinge each other as they enter the cylinder; sources of fuel and air supplies connected with said passages; ignition means adjacent the point where said passages meet; valves in said passages and a connection between the engine and said valves adapted to hold the valves open during the greater portion of the working stroke of the cylinder.

3. An internal combustion engine comprising a working cylinder having separate fuel and air passages opening thereinto, said passages meeting approximately at the point where they enter the cylinder; sources of fuel and air supplies connected with said passages; valves controlling the passage of fuel and air to the cylinder; a connection between the engine and said valves adapted to hold the valves open during the greater

portion of the working stroke of the cylinder; and ignition means reaching into the cylinder adapted to ignite the fuel as fed into the cylinder.

4. An internal combustion engine comprising a working cylinder; a piston in the cylinder; sources of fuel and air supplies connected with the cylinder; valves connected between the sources of fuel and air supplies and the cylinder controlling the admission of fuel and air to the cylinder; a mechanical connection between the valves and said piston adapted to hold the valve open during the greater part of the working stroke of the piston and closed during the remainder of the cycle of movement of said piston; and ignition means for igniting the fuel as fed into said cylinder.

5. In combination, an internal combustion engine comprising a working cylinder; a piston in the cylinder; sources of air and fuel supplies; means for admitting fuel and air from said sources of supply to the cylinder from a point near the beginning to a point near the end of the working stroke of the piston; and ignition means for igniting the fuel as fed into the cylinder.

6. In combination, an internal combustion engine comprising a working cylinder having a fuel passage and an air passage opening thereinto, said passages converging toward each other and meeting approximately at the point where they enter the cylinder; a spark plug having its sparking points adjacent the point where said passages meet; a piston in the cylinder; an air compressor connected with the air passage adapted to deliver air to the cylinder during the working stroke of the piston; a fuel compressor connected with the fuel passage adapted to deliver fuel to the cylinder during the working stroke of the piston; and valves in said passages connected with and operable by the piston and adapted to admit air and fuel simultaneously to the cylinder during a large portion of the working stroke of the piston and to cut off the air and fuel from the cylinder during the rest of the cycle of movement of said piston.

7. An internal combustion engine comprising a working cylinder; a fuel compressor connected with the cylinder; an air compressor connected with the cylinder; cooling means for cooling the fuel before the latter reaches the fuel compressor; cooling means for cooling the air before the latter reaches the air compressor; and cooling jackets on said compressors.

8. An internal combustion engine comprising a working cylinder; a fuel compressor connected with the cylinder, an air compressor connected with the cylinder independently of the fuel compressor; means for absorbing heat from the fuel and the air

before reaching said compressors; means associated with the compressors for absorbing heat due to compression of the fuel and air; and means for preventing overheating of the cylinder.

9. In combination, an internal combustion engine cylinder; fuel and air compressors; connections between the compressors and cylinder; throttle valves in said connections adapted to limit the flow of fuel and air to the cylinder and cause parts of the fuel and air to back up in said connections; storage tanks connected with said connections and adapted to receive the fuel and air backed up in said connections; and pressure controlling means connected between said tanks and connections adapted to equalize the pressures of air and fuel as they re-enter said connections.

10. In combination, an internal combustion engine cylinder; fuel and air compressors; connections between the compressors and cylinder; throttle valves in said connections adapted to limit the flow of fuel and air to the cylinder and cause parts of the fuel and air to back up in said connections; storage tanks connected with said connections and adapted to receive the fuel and air backed up in said connections; a pressure equalizing valve in communication with said connections adapted to control the flow of fuel and air from the storage tanks back to said connections at substantially the same pressures; valves connected with the intake openings of said compressors; and means operable by the pressures of the fuel and air in the storage tanks connected with the last-mentioned valves adapted to control the admission of fuel and air to the compressors.

11. In combination, an internal combustion engine cylinder; fuel and air compressors; connections between the compressors and cylinder; throttle valves in said connections; storage tanks; pipes connecting the storage tanks with the parts of said connections between the throttle valves and the compressors; check valves in said pipes adapted to stop the flow of air and fuel from the storage tanks; bypasses in said pipes around said check valves; and means connected with said bypasses tending to feed the fuel and air back to said connections at substantially the same pressures.

12. In combination, an internal combustion engine cylinder; air and fuel compressors connected together and adapted to compress air and fuel to substantially equal pressures; connections between the compressors and the engine cylinder; throttle valves in said connections; storage tanks; pipes connecting the storage tanks with said connections; and a pressure equalizing valve connected in said pipes tending to equalize

the pressures of air and fuel as such air and fuel pass from said storage tanks back to said connections.

13. In combination, an engine cylinder; air and fuel compressors having intake and exhaust ports; connections between said exhaust ports and said cylinder; throttle valves in said connections restricting the flow of fuel and air to the engine cylinder; storage tanks; pipes connecting the storage tanks with said connections adapted to convey parts of the fuel and air from said connections to said storage tanks; a pressure equalizing valve connected in said pipes and adapted to control the flow of air and fuel through said pipes in the direction toward said connections and cause such air and fuel to enter said connections at substantially the same pressures; and valves connected with the intake ports of the compressors and having communications with said pipes adapted to be operated upon by pressures of fluids in the latter to control the passage of air and fuel to said inlet ports.

14. In combination, an internal combustion engine cylinder; air and fuel compressors having intake and exhaust ports; a piston in said cylinder; a connection connecting said piston with said compressors causing the latter to compress air and fuel at substantially equal pressures; connections between said exhaust ports and said cylinder; throttle valves in said connections controlling the supply of fuel and air to the engine cylinder; storage tanks; pipes connecting the storage tanks with said connections adapted to convey fuel and air from said connections to the storage tanks; valves connected with the intakes of said compressors; springs normally holding said last mentioned valves opened; and connections between said pipes and last mentioned valves adapted to permit the latter to be closed by pressure of air and fuel in said pipes when the pressure of such air and fuel becomes greater than the strength of said springs.

15. In combination, an internal combustion engine cylinder; air and fuel compressors; storage tanks; a connection between each of the compressors, one of the storage tanks and the engine cylinder; valves in said connections in the portions of the latter leading to the engine cylinder adapted to throttle the supply of air and fuel to the engine cylinder and cause parts of the compressed air and fuel to back up into the storage tanks; and a valve connection in the portions of the connections leading to the storage tanks adapted to be operated by the pressures of the fuel and air in said last mentioned portions to facilitate feeding the air and fuel from the storage tanks to the

cylinder at pressures as nearly equal as possible.

16. In combination, a working cylinder; a piston in the cylinder; independent air and fuel compressors connected with the cylinder and adapted to deliver air and fuel separately to said cylinder during the full working stroke of the piston; and means associated with the compressors for maintaining the air and fuel cool during compression.

17. In combination, an internal combustion engine cylinder; means for supplying air and fuel separately to said cylinder under full working pressures; means for igniting the fuel as it enters the cylinder; and means for maintaining the air and fuel cool as they are placed under compression.

18. In combination, a fluid motor; air and fuel compressors; air and fuel storage tanks; connections between said motor, compressors and storage tanks; means controlling the supply of air and fuel to the motor and storage tanks; and means tending to equalize the pressure of fuel and air from the storage tanks to the motor.

19. In combination, a fluid motor; storage tanks; air and fuel compressors; connec-

tions between the motor, storage tanks and compressors; means in said connections adapted to automatically divert the excess air and fuel over what is used by the motor while running to said storage tanks; and means for equalizing the pressures of fuel and air before they enter said connections in their passage from said storage tanks.

20. In combination, an internal combustion motor; separate storage tanks for fuel and air under pressure; connections between said motor and said storage tanks; and a pressure equalizing valve in said connections operable by the pressures of air and fuel passing through said valve from both of said storage tanks and adapted to control the flow of fuel and air to the motor causing such fuel and air to be fed to the motor at substantially the same pressures in proper working proportions.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, on this 21st day of May, A. D. 1915.

ADOLPH ANTON NEFF.

Witnesses:

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CHARLES H. SEEM.