J. F. MURPHY.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED APR. 9, 1919.

1,377,139. Patented May 3, 1921.

2 SHEETS—SHEET 1.

Fig. 1.

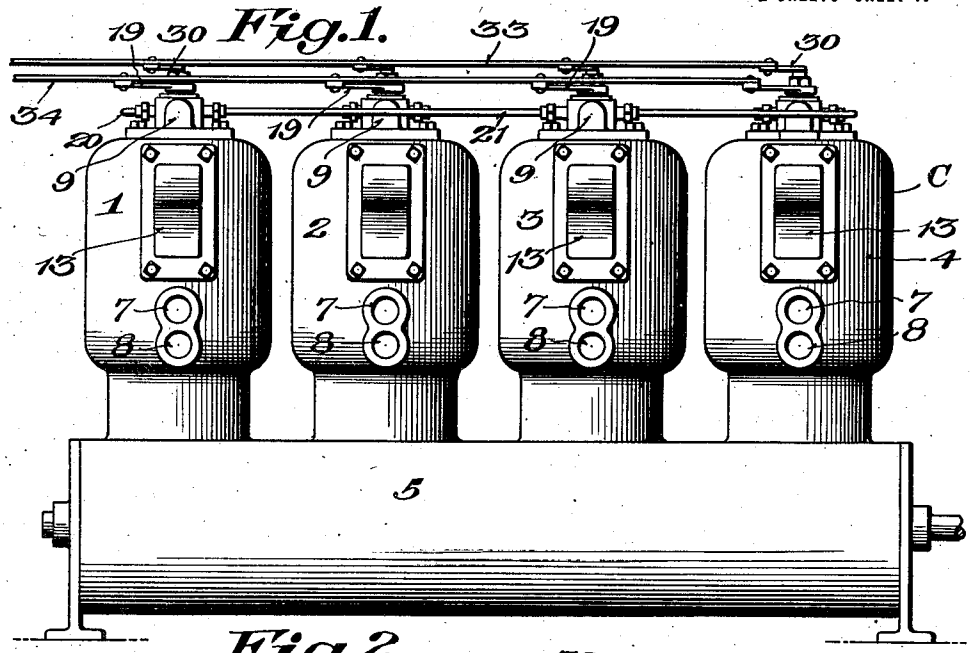
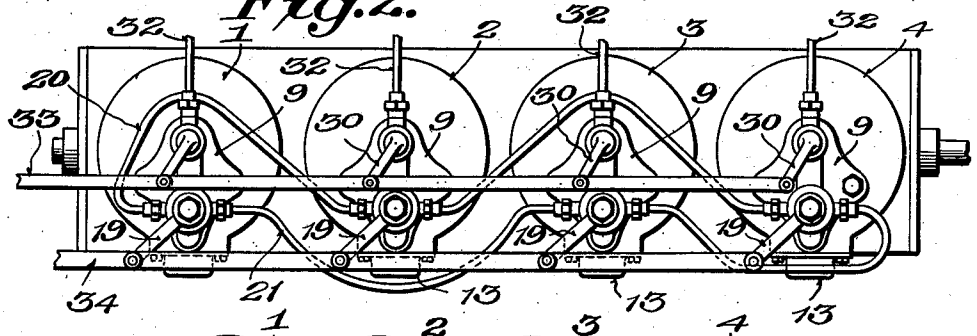


Fig. 2.



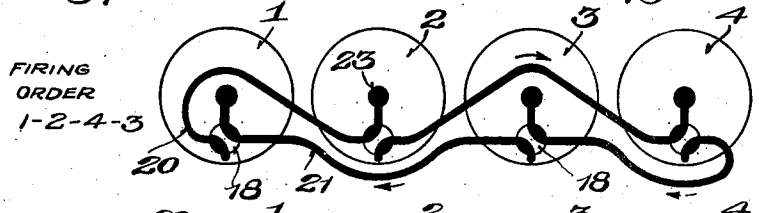


Fig. 5.

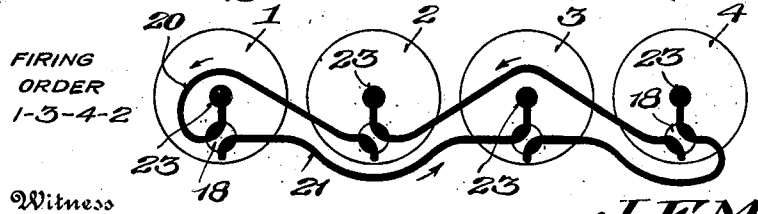


Fig. 6.

Witness

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2 SHEETS—SHEET 2.

Fig. 3.

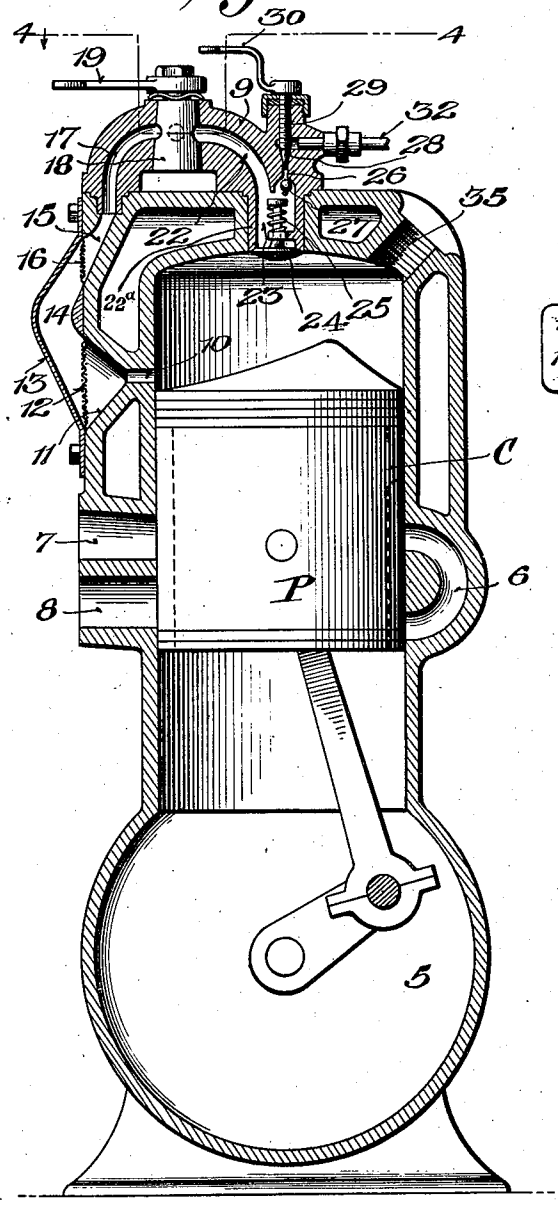
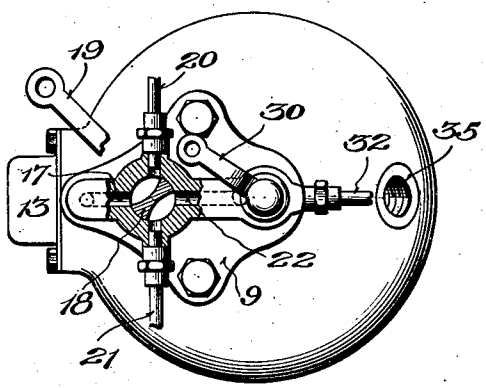


Fig. 4.



Witness

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INTERNAL-COMBUSTION ENGINE.

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To all whom it may concern:

Be it known that I, JOHN F. MURPHY, citizen of the United States, residing at Louisville, in the county of Jefferson and State of Kentucky, have invented certain new and useful Improvements in Internal Combustion-Engines, of which the following is a specification.

This invention relates to internal combustion engines and has particular reference to an improvement in motors of the type which operate without automatic ignition.

A primary object of the invention is to secure greater thermal efficiency in a motor of a standard construction by increasing compression beyond the point of automatic ignition to enable the use of heavier and consequently cheaper fuels, while at the same time greatly simplifying the general motor structure. Although it has been heretofore proposed to operate an internal combustion motor by injecting the liquid fuel into a cylinder where the air is compressed above the pressure generated by the combustion of fuel in the inclosed firing chamber (Diesel type), this injection of the fuel has only been possible by the use of a separate pump. And, furthermore, in engines of this type it is necessary that the cylinders be of relatively great thickness, and needless to say a power plant thus constructed is not only complicated, cumbersome, and expensive, but is impossible of embodiment in small units, and therefore impractical for general commercial use.

In internal combustion motors as commonly built the thermal efficiency of the motor is in direct proportion to the amount that the fuel mixture is compressed before ignition takes place. Recognizing this the present invention proposes an improvement susceptible of embodiment in all multiple cylinder engines of either two or four cycle type, wherein the size of the cylinders is such that the final compression of air is greater than that necessary where automatic ignition is employed, but less than the pressure created by the explosion of a similar fuel charge in an adjacent cylinder of similar capacity. Thus, the invention contemplates the provision of an engine of standard design wherein the construction and arrangement is such that a condition existing in the normal operation of the engine may be used to cause the injection of the liquid fuel into a compressed atmosphere for the purpose of being thereby ignited to give the desired working stroke to the piston.

Another object of the invention is to provide a power plant which is susceptible of embodiment in small units for vehicle use and requires no gearing to effect a reverse drive. That is to say, it is proposed to provide an engine of the type which may be conveniently used on automobiles, and which includes novel means for changing the firing order of the cylinders to reverse the direction of rotation of the crank shaft.

A further object of the invention is to provide a simple, practical and reliable means for controlling the speed of the engine under varying conditions of use without the aid of a carbureter, thereby eliminating a further source of trouble and article of equipment.

With the above and other objects in view which will more readily appear as the nature of the invention is better understood, the same consists in the novel construction, combination and arrangement of parts hereinafter more fully described, illustrated and claimed.

A preferred and practical embodiment of the invention is shown in the accompanying drawings, in which:

Figure 1 is a side elevation of a motor constructed in accordance with the present invention.

Fig. 2 is a top plan view thereof.

Fig. 3 is a vertical sectional view of a cylinder constructed in accordance with the present invention.

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 3.

Fig. 5 is a diagrammatic view showing the position of the control valves when the motor is being operated to give a forward drive.

Fig. 6 is a view similar to Fig. 5 showing the position of the control valves when the motor is reversed.

Similar reference characters designate corresponding parts throughout the several figures of the drawings.

In carrying the present invention into effect, it is proposed to eliminate the automatic electrical ignition system except possibly for starting purposes when the engine is cold. The invention therefore is directed to that type of engine wherein the fuel is injected into a compressed atmosphere and there vaporized and exploded to give the de-

sired working stroke to the piston. However, in this connection it is pointed out that the present invention is not to be confused with the type of engine wherein the fuel oil is injected into a volume of compressed air which is compressed above the pressure generated by the combustion of the fuel in the firing chamber of an adjacent cylinder. In engines where the compression is frequently brought as high as forty-five atmospheres, it is necessary that the fuel oil be injected into this highly compressed body of air by means of a separate pump, and in this case the combustion is not instantaneous with the injection of the fuel into the compressed air but proceeds as the piston moves out to the end of its working stroke. The present invention however contemplates a novel construction whereby the final compression of the air in the cylinder is less than the pressure of combustion on the working stroke in an adjacent cylinder, this compression however being greater than that usually employed where an electrical spark automatically ignites the gaseous fuel charge near the end of the compression stroke.

By way of illustrating one practical structure for carrying the present invention into effect, reference may be had to the drawings which show a motor of the four cylinder type which operates on the two cycle principle. The cylinders of this motor are preferably of the general structure and arrangement shown in Fig. 4 of the drawings, and although shown as a water cooled unit, it will of course be understood that the invention may be adapted with equal efficiency to an air cooled unit, or to a four cycle motor having sufficient cylinders to maintain continuity of operation.

The individual cylinders 1, 2, 3, and 4 are of duplicate construction and the operative connections between the same are also identical. Therefore, a description of one will suffice for the others, and by reference to Fig. 4 it will be observed that within the cylinder C slides piston P, the same coöperating with the closed crank case 5 to operate as a compressor to transfer compressed air at the end of the working stroke through the port 6 to the working chamber of the cylinder and not only scavenge the same of the dead gases which pass through the exhaust port 7, but at the same time furnishes a fresh air-charge to be compressed for the next working stroke. With the arrangement described, obviously when the piston P reaches its upward limit of movement at the upper end of the compression stroke air will be sucked into the crank case 5 through the intake port 8 to be compressed on the working stroke of the piston and then repeat the cycle above described.

The upper member of the cylinder may be fitted with a duplex valve-unit designated generally as 9, the same containing a fuel supply valve and a reversing valve as will presently appear, while the side wall of the cylinder is provided with a dead gas outlet port 10 at a suitable point above the exhaust 7. This port 10 opens into a flaring recess 11 in the well of the cylinder which may be provided with a screen 12 and a cover plate 13 which provides a conduit 14 leading back into the body of the cylinder C to establish communication with the opening or passage 15, also covered by a screen 16, which like the screen 12, prevents the transmission of flame from the combustion chamber of the cylinder through the passages 14 and 15.

The said opening 15 discharges into a passageway 17 of the valve-unit 9, which latter passageway is a part of a two-way control valve which includes the plug 18 operated by an exterior handle 19. This plug 18 is adapted to control communication between the cylinder on which it is mounted and an adjacent cylinder, and to this end has fitted thereto a discharge pipe 20 and intake pipe 21 which leads from the combustion chamber of an adjoining cylinder, while the said pipe 20 leads to the fuel supply valve of the cylinder on the opposite side. For instance assuming that the cylinder described is cylinder No. 1, the pipe 20 will lead to the fuel supply valve of cylinder No. 2 as will be observed from Fig. 2 of the drawing, while the pipe 21 leads from cylinder No. 3. Thus, as the firing order in the arrangement shown is 1—2—4—3 it will be clear that as the cylinder 3 performs its working stroke the products of combustion in the said cylinder will flow through pipe 21 to supply cylinder 1 with the proper fuel charge in the particular manner hereafter referred to, while as cylinder 1 completes its working stroke the exploded gases will pass out through port 10 and passages 14, 15, 16 and 17 to and through pipe 20 to supply cylinder No. 2 with its fuel charge at the proper point of the cycle, namely near the end of the compression stroke of that cylinder.

Referring to the means for supplying the fuel oil to the cylinder it is to be observed that the valve-unit casting 9 is also provided with the passage-way 22 leading to a sleeve 22^a which provides an enlarged fuel accumulating chamber 23 that is normally closed by a puppet valve 24 held to its seat against the mouth of the chamber under tension of the spring 25. This fuel accumulating chamber 23 is in communication with a fuel passage 26 whose discharge end is guarded by ball valve 27 for preventing back-pressure in the fuel supply system. The upper end of the passage-way 26 is formed with a suitable seat 28 for accommodating the head of a needle valve 29 which is fitted with an exterior operating handle 30 and controls the supply of fuel

entering the supply passage of the casting 9 from a fuel supply tube 32 leading from a fuel tank wherein the fuel is stored under pressure.

The needle valve 29 is preferably set to allow a certain quantity of liquid fuel under pressure to flow through the passage 26 in a unit of time, and hence there is a certain desirable governing action due to this feature. That is to say, should the load on the motor be suddenly increased so as to slow down the rotation of the crank shaft there is a longer interval of time between cycles in each cylinder, and more fuel will have accumulated around the puppet valves between working strokes. This automatically causes greater pressure and consequently greater turning effort at slow speeds. In other words, the power output is governed, the action being that as the speed is lowered by increased load or road conditions, as on approaching a hill, if the motor is used in a motor car, the effective turning effort or torque of the motor will be increased so that the power developed will remain nearly constant within wide ranges of speed, and the thermal efficiency is greater than is possible with a motor using a carbureted mixture and low compression varying with every position of the throttle.

The needle valves 29 are preferably connected by a common actuating member 33, whereby all of the valves may be given a uniform setting and when the valves are raised a certain desired distance from the seat 28 in the upper end of the passage 26 it will be apparent that fuel under pressure will flow into the chamber 23 and there be held until released by the puppet valve 24. Now it will be recalled that the passageway 22 in the valve casting which leads to the chamber 23 is under control of the valve 18 and for the setting of the valve shown in Figs. 3 and 4 this passage 22 is in communication with the pipe 21 which leads from the working chamber of cylinder No. 3 that is of the same construction as cylinder 1 shown in Fig. 3 of the drawings. Therefore, as cylinder No. 3 performs its working stroke and its piston passes the port corresponding to 10 of the cylinder 1 shown in Fig. 3, the exploded gases will rush through the passage corresponding to 14, 15 and 17 of Fig. 3 and to the valve corresponding to 18 on the top of cylinder No. 3 and thence through the pipe 21 to the valve 18 on cylinder No. 1 which will deflect the same into the passage 22 and cause the puppet valve 24 to be unseated as the piston P in cylinder No. 1 reaches the proper point of its compression stroke to thereby inject the liquid fuel into the highly compressed air in the combustion chamber. As the air has been previously heated by high compression to a point above the flash point of the fuel, combustion begins immediately and the resulting increase in pressure in the combustion chamber of cylinder No. 1 closes the puppet valve 24 at once. The piston P of cylinder No. 1 then continues down on its working stroke until it uncovers the port 10, whereupon the exploded gases in the working chamber of cylinder No. 1 having reached their highest point of expansion will pass through the said port and thence through the screen 12, passage 14, screen 16, passages 15 and 17 to the valve 18 which will direct the same into the pipe 20 leading to the fuel supply chamber of cylinder No. 2. This cycle is repeated in each cylinder as long as fuel is supplied to the chamber above the puppet valves.

With the foregoing arrangement it will be apparent that the distinctive feature of the present invention is the injection of a raw fuel charge into the highly compressed air of a cylinder wherein the piston is performing its compression stroke, whereby the fuel is automatically mixed and burned to cause the working stroke of the piston, which upon its downward movement uncovers a port in communication with the fuel supply means of an adjoining cylinder whereby fuel will be released in that cylinder at the proper point of the cycle. The effect of the inert gas in the passages leading from the working cylinder of one chamber to the fuel supply chamber of the next to fire is substantially that of a piston since it forces the liquid fuel accumulated around the puppet valve of each cylinder into the highly compressed air in the cylinder whereupon it is instantaneously exploded. The effect of this immediate explosion is to close or seat the puppet valve to prevent continued movement of gases through the communicating passages, and furthermore, by the employment of a double screen in the passage leading from the working chamber of the cylinder, all possibility of flame being transmitted through the passage is eliminated. This safeguard prevents premature explosion of the fuel charge even if oxygen of the air is present.

In connection with the control valves 18 which have the operating handles 19, it is to be noted that for the setting of the same shown in Fig. 5 of the drawings, the firing order of the cylinders will be 1—2—4—3 which will give the proper rotation of the crank shaft for a forward drive. However, when the setting of the valve plugs 18 is reversed to the position shown in Fig. 6 of the drawings, the firing order of the cylinder will also be reversed, namely, 1—3—4—2, and thereby produce a reverse drive of the crank shaft, on which the cranks are set at 90°. For convenience in effecting the reversal of the motors the said handles 19 of the valve plugs 18 may be connected by a

suitable operating bar 34 or its equivalent.

When it is desired to start the motor, the fly wheel may be rocked back and forth or turned over after a cylinder has been primed with a small quantity of liquid fuel, or for the purpose of insuring easy starting of the motor, especially when cold, a spark plug inserted in the opening 35 may be utilized. However, after one cylinder has fired the continued operation of the motor is assured.

Without further description it is thought that the construction of the present engine is such that the distinctive feature of utilizing the combustion of the gases on the working stroke to inject the raw fuel charge into a highly compressed atmosphere of an adjoining cylinder may be readily carried into effect without the use of separate compressors or other cumbersome accessories which add to the cost and complexity of engine structure.

I claim:

1. An internal combustion engine including a plurality of cylinders, means for supplying raw fuel directly to each cylinder, and means actuated by the pressure of gases performing the working stroke of one cylinder to release the fuel charge supplied by said means into the compressed atmosphere of the next cylinder to fire.

2. An internal combustion engine including a plurality of cylinders, means for supplying a fuel charge to said cylinders, and means actuated by the pressure of gases performing the working stroke in one cylinder, to release the fuel charge near the end of the compression period in an adjacent cylinder.

3. An internal combustion engine including a plurality of cylinders, means for supplying fuel to each of said cylinders, means for controlling the admission of fuel into said cylinders, and a conduit leading from the combustion chamber of each cylinder to the means for releasing the liquid fuel into the compressed atmosphere of the next cylinder to fire.

4. An internal combustion engine including a plurality of cylinders, means for supplying fuel to each cylinder, a valve for controlling the admission of fuel to the cylinder, a pipe line communicating with the space above the piston in each cylinder and with the space behind the said valve whereby the exploded gases on the working stroke of a leading cylinder will actuate the valve to release the fuel on the compression stroke of the piston in a following cylinder.

5. An internal combustion engine including a plurality of cylinders, means for supplying fuel under pressure to each cylinder, means for collecting said fuel and releasing it into the cylinder during compression at the proper point of the cycle, and a pipe line in communication with the space above the piston of a leading cylinder and also in communication with the means for collecting the fuel whereby the explosion of gases in a leading cylinder will operate the said means.

6. An internal combustion engine including a plurality of cylinders each having intake and exhaust ports and a separate gas discharge port, fuel supply means, means for accumulating fuel furnished by said supply means including a chamber having an outlet and a spring pressed valve normally covering the said outlet, and a pipe line leading from the gas port of each cylinder to the chamber behind the valve of the next cylinder of the series to fire, the said pipe line conveying the compression of combustion to said chamber to unseat the valve near the end of the compression stroke of the said next cylinder to fire.

7. An internal combustion engine including a plurality of cylinders each having intake and exhaust ports and a separate gas discharge port, fuel supply means, means for accumulating fuel furnished by said supply means including a chamber and a spring pressed valve normally covering the entrance of the same, and a pipe line leading from the gas port of each cylinder to the chamber behind the valve of the next cylinder of the series to fire, and a valve plug in said pipe line for reversing the flow of gases to effect a reverse operation of the motor.

8. An internal combustion engine including a plurality of cylinders, means for supplying fuel under pressure thereto, means for accumulating a fuel charge for each cylinder in proportion to the load including a fuel receiving chamber and a spring pressed valve operating to normally close the entrance of said chamber, and a pipe line leading from the space above the piston in a leading cylinder to said fuel collecting chamber, whereby the pressure of exploded gases of a leading cylinder will actuate the valve of the following cylinder to fire to release a fuel charge into the compressed atmosphere of said following cylinder.

9. An internal combustion engine including a plurality of cylinders, means for supplying fuel to each cylinder, means for collecting a fuel charge for each cylinder, and pipe connections between the successively firing cylinders and the means for collecting the fuel charge, and manually controlled valves in said pipe lines for effecting the reversal of gas flow in said pipe lines to reverse the engine.

10. An internal combustion engine including a plurality of cylinders, each cylinder having intake and exhaust ports and a separate gas port, a valve casting fitted to the head of each cylinder and including a sleeve

opening into the working chamber of the cylinder, said casting having intersecting passages respectively communicating with said sleeve and the gas port in the cylinder, and adjacent opposite cylinders, a valve plug located at the intersection of said passages, a spring pressed valve mounted to normally close the end of the sleeve opening into the said working chamber of the cylinder, a fuel supply inlet above said sleeve, and a needle valve for controlling the passage of fuel through said supply inlet.

11. An internal combustion engine including a plurality of cylinders having air intake and exhaust ports controlled by the pistons, raw fuel supply means for each cylinder, means for injecting an air charge into the cylinder at the beginning of the compression stroke, and means actuated by the pressure of the gases of combustion performing the working stroke of one cylinder to inject the fuel charge furnished by said raw fuel supply means into the compressed atmosphere of the next cylinder to fire, near the end of the compression stroke.

In testimony whereof I hereunto affix my signature in the presence of two witnesses.

JOHN FRANCIS MURPHY.

Witnesses:
T. E. JAEGERS,
S. M. HARRIS.