K. NICOLL.

INTERNAL COMBUSTION OR EXPLOSION ENGINE.

APPLICATION FILED JUNE 27, 1910.

1,146,440. Patented July 13, 1915.

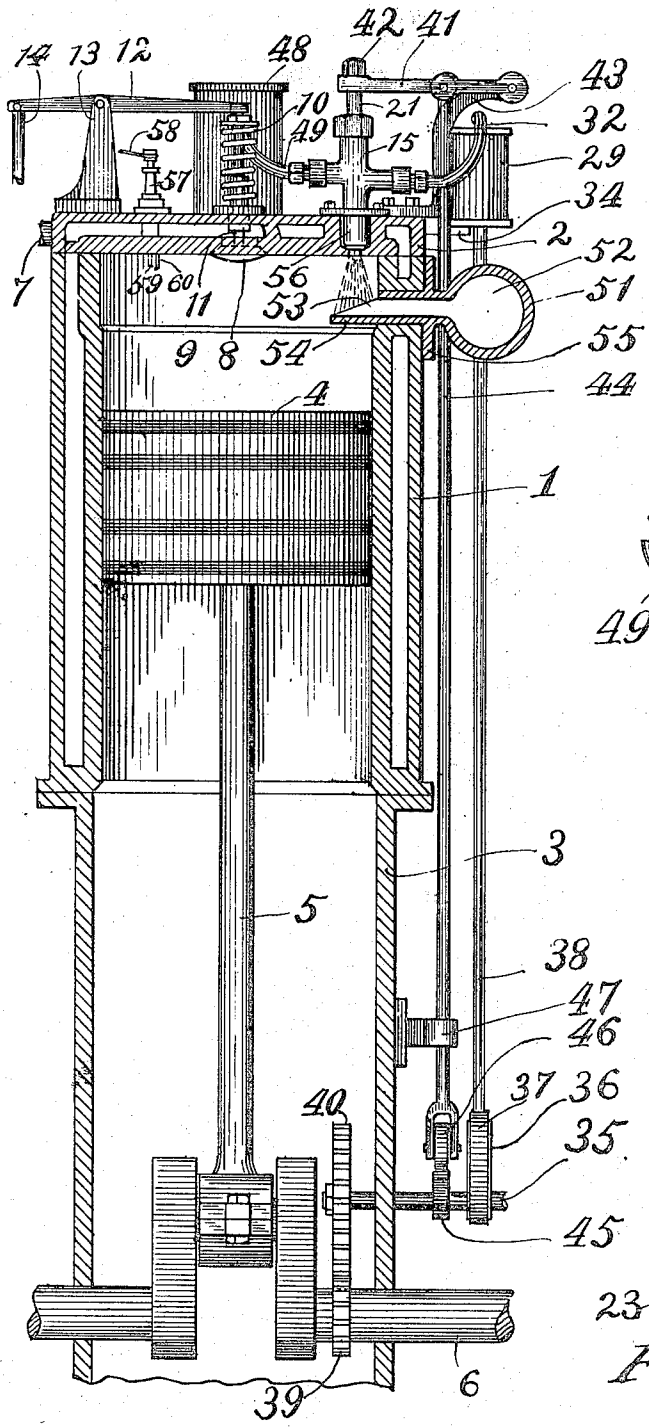
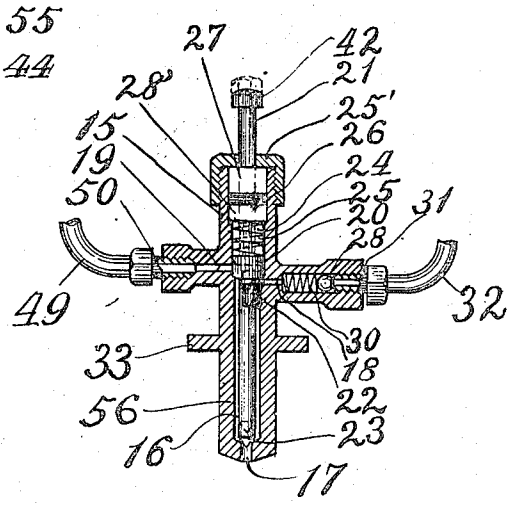


Fig. 1.

Fig. 2.



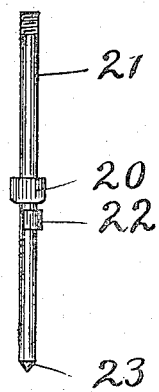


Fig. 3.

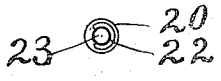


Fig. 4.

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION OR EXPLOSION ENGINE.

1,146,440. Specification of Letters Patent. Patented July 13, 1915.

Application filed June 27, 1910. Serial No. 569,188.

To all whom it may concern:

Be it known that I, KONRAD NICOLL, a subject of the King of Norway, residing in the city of Milwaukee, county of Milwaukee, and State of Wisconsin, have invented certain new and useful Improvements in Internal-Combustion or Explosion Engines, of which the following is a specification.

This invention relates to that class of engines commonly known as internal combustion, or explosion engines, and more particularly to the construction, arrangement and mode of operation of the injection nozzle and the mechanism for introducing, vaporizing, mixing and igniting the combustible fluid or fuel.

The principal object of the invention is to provide a simple, economical and efficient internal combustion or explosion engine.

Other and further objects of the invention are to provide an internal combustion or explosion engine with means for introducing, vaporizing, mixing and igniting combustible fluid or fuel, adapted to prevent or reduce to a minimum the liability to premature explosions and to insure ignition at the proper instant, and also to insure complete combustion, and particularly to enable a constantly heated element to be employed for producing ignition and thorough vaporization and at the same time reduce to a minimum the liability to premature explosions; to provide means whereby an internal combustion engine is enabled to be run in an efficient manner at a high temperature and to keep an igniting element constantly heated from the explosions and without causing premature explosions; to enable gasolene, kerosene, acetylene, crude petroleum or other desired combustible fluid to be intermixed with the desired proportion of air, injected into and intermixed with air under pressure in the explosion chamber and vaporized and ignited or exploded in an efficient manner and in such a manner as to reduce to a minimum or entirely prevent premature explosions while using either a constantly heated element or an electric sparker or both for the purpose of igniting the explosive fluid, and to enable each charge of air contained in the explosion chamber or piston chamber to be compressed by the action of the piston to or near the point of highest compression before any combustible fluid or oil is introduced therein, and a charge of air and oil or fuel to be intermixed in proportions which form a non-explosive mixture of combustible fluid and forced into and intermixed with the air so compressed in the explosion chamber and vaporized and exploded, all in such a manner that the fluid contained in the explosion chamber is non-explosive until the proper moment for the explosion to take place.

Other and further objects of the invention will appear from an examination of the drawing and the following description and claims.

The invention consists in the features, combinations, and details of construction herein described and claimed, and in the method of compressing, introducing, mixing, vaporizing and igniting the combustible fluid or fuel.

In the accompanying drawing Figure 1 is a view in vertical section through the center of an engine provided with my improvements and showing in elevation an injection nozzle, valve operating mechanism, fuel pump, and compressed air supply reservoir or device, and, in section, the hollow ball or igniting device, all constructed in accordance with my invention; Fig. 2, a central vertical sectional view of my improved injection nozzle; Fig. 3, a view in side elevation of the injection nozzle valve-stem with the air and fuel valves thereon, and Fig. 4, a bottom end view of the valve stem and valves shown in Fig. 3.

In the art to which this invention relates it is well known that when a constantly heated element is used for igniting the explosive fluid and fuel is introduced into the piston chamber or explosion chamber in the ordinary manner so as to form an explosive mixture which is compressed by the piston during its entire compression stroke or the greater portion thereof and prior to the proper time for an explosion to take place there is great liability to premature explosions. It will also be readily understood that merely pumping oil into the explosion chamber will not overcome the objection, and, if performed after the air in the piston chamber is compressed, will not result in a complete intermixing and vaporization of the combustible fluid or in the complete combustion and assured and properly timed explosion desired, to any such an extent as these desirable objects are accomplished by forcing intermixed air and oil

under pressure and in such proportions that the mixture passing through the mouth of the injection nozzle is non-combustible until forced into the compressed air in the explosion chamber and vaporized by the continuously heated element extending into said chamber in position to deflect the incoming fuel, and by the heat of the chamber and the air contained therein, in accordance with my invention.

In constructing an internal combustion or explosion engine provided with means for introducing, mixing, vaporizing, compressing and igniting combustible fluid or fuel in accordance with my improvements I provide an engine cylinder 1 having a cylinder head 2, a casing or frame portion 3, a piston 4 provided with a piston rod or pitman 5 operatively connected with a crank-shaft 6, an air-inlet passage 7, an outlet passage (not shown) leading from the explosion chamber, an air-inlet valve 8 for the air-inlet passage 7 which leads into the explosion chamber 9, mechanism for automatically operating said inlet valve, comprising a spring 10, valve stem 11, a walking beam 12, pivotally mounted upon a suitable support 13, and an operating rod 14 connected with said walking beam and operatively connected with the cam or crank shaft of the engine in any ordinary or desired manner, all of which (including an outlet valve and valve operating mechanism and other well known parts of an internal combustion engine of any known type, not shown) may be of any desired or ordinary known type, form or construction.

An injection nozzle is provided which is constructed in accordance with my invention, as follows: The injection nozzle, as shown in the drawings, has a main body or casing portion 15 which forms a mixing chamber 16 having an injection hole or discharge passage 17 adapted to communicate with the explosion chamber or interior of the piston cylinder of the engine. The nozzle is also provided with an oil or fuel inlet or supply passage 18, and an air supply passage 19, each of which leads into or is adapted to communicate with the chamber 16. An air-valve, which is preferably substantially cylindrical and of somewhat greater diameter than the portion of the chamber 16 in which it is seated with its bottom end normally intermediate the fuel or oil inlet passage 18 and the air inlet passage 19, is mounted upon a valve stem 21 in position to close the air inlet passage 19 when said air-valve 20 is seated or in its lowermost position, as shown in full lines in Fig. 2. A fuel-inlet valve 22, which is preferably of segmental or nearly semi-cylindrical form as shown in Figs. 3, 4, and 2 is mounted upon or made integral with the valve stem 21 and in sliding engagement with the correspondingly cylindrical wall portion of the chamber 16. This fuel valve 22 has its upper end a sufficient distance below the bottom end of the air-valve to form a space between said valves which registers with the mouth of the inlet passage 18 so as to permit oil or fuel to pass from said passage and through said space between the valves and into the chamber 16 when the valves are in their lowered position. The fuel valve 22 and the air valve 20 are thus in fixed relation and may be made integral with the valve stem 21, and the bottom end 23 of said valve stem is located inside of the chamber 16, and is conical and seated in the bottom of said chamber in position to form a valve for opening and closing the injection hole or discharge passage 17 of the nozzle. The portion of the nozzle body above the fuel valve 22 and fuel inlet passage 18 has a bore or central opening 24 of larger diameter than the portion of the chamber 16 which is below the fuel passage 18, and the air-valve 20 is adapted to slide up and down in said bore. And a compressible spring 25 encircles the valve stem above and in operative engagement with the air valve and is adapted to move the air valve 20, the fuel valve 22, and the bottom valve 23 downward from the positions shown in dotted or broken lines in Fig. 2 to the positions shown in full lines in said figure. The upper end of the nozzle body is provided with a screw cap 25′ having a central perforation through which the valve stem extends, and a suitable packing 26 between packing glands 27 and 28′ encircles the valve stem on the inside of the nozzle body and between the cap and the compressible spring 25.

A ball valve 28 is seated in the fuel inlet passage 18 at a point between the fuel-valve 22 and the oil or fuel pump 29 or source of fuel supply, and is provided with a compressible spring 30 between said ball valve and the point of communication between the fuel passage 18 and the chamber 16 adapted to hold the ball yieldingly in its seat when the pressure of the incoming fluid is not sufficient to overcome the tension of the spring or unseat the ball. A nipple 31 screwed into the nozzle body forms a seat for the ball valve, and a pipe 32 is connected at one end with the fuel pump or source of fuel supply 29 and at its other end, by means of said nipple, with the nozzle, so that the passage 18 leads from the pump 29 to the chamber 16. The nozzle is provided with a flange 33 by means of which it may be secured to the engine, with the aid of bolts and nuts, but it is also capable of being secured in operative position upon the engine and preferably upon the cylinder head, in any ordinary known or desired manner, and the nozzle and all of its parts may be made of any desired metal.

The pump 29 is operatively connected with the crank shaft or any desired driven shaft of the engine, preferably in such a manner that the pump piston will make a stroke for each charge of combustible fluid to be introduced into the explosion chamber. Although any suitable means for operating the fuel pump may be employed, it is here shown supported by a bracket 34 and operatively connected with a cam shaft 35 by means of an eccentric 36 on said cam shaft, an eccentric strap 37 on the eccentric, and a pump rod or pitman 38 having its lower end connected with the eccentric strap and its upper end operatively connected with the piston of the pump in any ordinary known or desired manner. The cam shaft 35 is operatively connected with the crank shaft 6 of the engine by means of a spur gear 39 on the crank shaft and a spur gear 40 on the cam shaft and in toothed engagement with the pinion or gear 39.

The valves 22, 20 and 23, and the valve stem 21 on which they are supported are operated in one direction by the compressible spring 25 as already stated. They are automatically operated in the opposite direction, or raised and released positively and in such a manner that the fuel valve 22 will close the fuel supply passage 18 and the valves 20 and 23 will simultaneously or immediately thereafter and with the same upward movement of all of said valves, open the passages 19 and 17 and cause them to remain open until the air inlet valve 20 and the injection nozzle discharge valve 23 are closed and the fuel valve 22 opened by the action of the compressible spring 25. In order to accomplish this I provide a lever or walking beam 41, one end of which is connected with the valve stem 21 by means of a nut 42 or in any suitable manner, and the other end of which is pivotally mounted upon a suitable support or bracket 43. An operating rod 44 is pivotally secured to the lever 41, and is operatively connected with a driven shaft such as the cam shaft 35 by means of a cam 45 on said shaft adapted to operate the rod and thereby the lever 41 and valve stem 21. An antifriction wheel 46 is interposed between the end of the rod 44 and the cam 45, and is rotatably mounted between fork arms of the rod in the ordinary manner. The lower end of the rod is slidably supported by a bracket 47, and the cam 45 and the eccentric 36 are of such conformation and so disposed with respect to each other that the fuel pump will be operated so as to force combustible fluid into the chamber 16 while the valves on the valve stem 21 are in lowered position and said valves will then be raised by the action of the cam and then suddenly released when in the position shown in broken lines in Fig. 2, and moved down by the spring 25 to the position shown in full lines in said figure, as already suggested.

An air supply receptacle 48 containing compressed air under a higher pressure than the air in the explosion chamber when the engine piston is at the end of its compression stroke, is provided, and connected with the injection nozzle by means of a pipe 49 and a nipple 50 through which the air inlet passage 19 leads to the interior of the compressed air supply reservoir, so as to connect the latter with the chamber 16 in the nozzle when the air valve 20 is open. The compressed air reservoir may be in the form of a pump or may be provided with a pump of any desired type (not shown) adapted to be operated by the engine, or may be connected with any desired ordinary means for supplying air under the desired pressure, to the tank.

An igniter made preferably in the form of a hollow bulb or ball 51 forming an inner chamber 52, and having a hollow neck 53, the inner end of which forms a lip 54 is mounted in the side wall of the engine cylinder to which it is secured by means of an integral flange 55 and bolts or screws (not shown) or in any desired manner. The igniter is formed of metal, preferably cast iron, and is so mounted that the hollow neck 53 extends through the side wall of the engine cylinder and the inner end or lip portion 54 of the neck projects into the explosion chamber transversely of the latter and with the concave or hollow side of the lip toward the cylinder head and adjacent to the inner end 56 and injection hole or discharge passage 17 of the nozzle mounted in the cylinder head, said lip being substantially at right angles to the discharge passage in the nozzle and in position to receive and direct combustible fluid toward the opposite side of the engine cylinder and explosion chamber, and also to deflect into the interior of the bulb or hollow igniter, combustible fluid injected into the combustion chamber and against the hollow side of said lip through the injection nozzle.

The nozzle may be heated by means of a torch (not shown) or in any desired manner until its temperature is sufficiently high to ignite the combustible fluid in the explosion chamber, and the heat from the explosions and compression serve to keep it constantly hot enough to vaporize and ignite said fluid or fuel. An electric igniter may also be provided comprising a spark plug 57 connected with and embraced within an electric circuit in the usual manner by suitable wiring 58, and having terminals or electrodes 59 and 60 inside of the combustion chamber. It will thus be seen that the igniter bulb or ball 51 and lip 54 may be initially heated by the explosion of combustible fluid ignited by the electric igniter,

and is adapted to be used either in conjunction with or without the electric igniter, and that, whether an electric sparker is used or not, the igniter formed by the bulb or ball 51, hollow neck 53 and lip 54 is adapted to be kept constantly heated by the explosions to a temperature which will ignite the charges and also vaporize the injected combustible fluid and thoroughly intermix it with the compressed air in the explosion chamber so as to form a thoroughly homogeneous or uniform explosive mixture inside of the explosion chamber at and not before the proper moment for the respective explosions to take place. Proper ignition and combustion are thus produced, and premature ignition is prevented by introducing intermixed air and oil into the compressed air, in the cylinder at, and not until the desired moment of ignition.

In operation, air is admitted to the piston or explosion chamber through the main air inlet passage by means of the valve 8, and is then compressed by the return or compression stroke of the piston. When the air in the explosion chamber is at or near its highest point of compression; the valve stem 21 is raised from the position shown in full lines in Fig. 2 to the position shown in broken lines in said figure, thereby opening the passages 19 and 17 in the injection nozzle and closing the fuel inlet passage 18 by means of the fuel valve 22—the chamber 16 of the nozzle having been supplied with a charge of combustible fluid through the passage 18 and the ball valve 28 having been closed before the beginning of the compression stroke of the piston 4. Upon opening the air valve 20 and valve 23 and thereby the air passage 19 and injection passage 17 air under pressure exceeding the pressure of the compressed air in the explosion chamber is forced into the chamber 16 of the nozzle and intermixed with the combustible fluid or oil in said chamber in proportions which are by preference such as to make a nonexplosive mixture of combustible fluid. The intermixing of combustible fluid or fluid hydro-carbons and compressed air is accomplished by pumping the compressible fluid through inlet 18 and into chamber 16 in the nozzle, while air previously introduced into said chamber through air inlet 19 still remains in said chamber. Upon opening air inlet 19 and port 17, air is forced into and through the combustible fluid in the chamber 16, and through said chamber, and thus thoroughly intermixed with the charge of combustible fluid or hydro-carbons in said chamber during the forcing of the air and combustible fluid through the chamber. The air and combustible fluid thus intermixed in the chamber 16 in the nozzle are together forced into the explosion chamber and against the lip or inwardly projecting end 54 of the metallic igniter which is kept heated to a sufficiently high temperature to ignite the combustible mixture at the moment it becomes explosive. The mixture thus forced into the explosion chamber, preferably during and at or near the end of the compression stroke of the piston, and against the heated metallic igniter lip is quickly and thoroughly vaporized and intermixed with the compressed air in the explosion chamber so as to form an explosive mixture at the moment when the explosion should take place. Part of the mixture thus forced into the explosion chamber and against the heated lip is deflected into the passage 53 and chamber 52 in the hollow igniter, and thoroughly vaporized and ignited or exploded, causing a flash of burning or exploding gases to pass transversely across the explosion chamber from the transversely disposed passage 53 in the igniter and through the vaporized and compressed explosive mixture in the explosion chamber, in such a manner as to produce substantially complete combustion, resulting in a high degree of efficiency. The combustible fluid injected against the lip 54 is vaporized and deflected and quickly and thoroughly intermixed with the compressed air already in the explosion chamber in such a manner as to form an explosive mixture at and not before the proper moment of the explosion to occur, so that premature explosions are prevented. The charges may be ignited by means of the electric igniter, if desired, until the igniter bulb or ball becomes sufficiently heated, or to any desired extent. The metallic igniter bulb or ball, however, may be initially heated by means of a torch as already suggested, and is adapted to be used either with or without the electric igniter, and to be kept constantly heated by the explosions.

I claim:

1. In an engine of the class described, the combination of a piston cylinder, a piston in said cylinder, an injection nozzle provided with a chamber having a passage leading into the interior of the piston cylinder and provided with a combustible fluid inlet passage and an air supply passage communicating with the chamber in the nozzle, an air inlet valve for said air supply passage, a fuel inlet valve connected with the air inlet valve and movable with the latter into position to close the combustible fluid inlet passage simultaneously with the movement of the air inlet valve to opened position, a valve intermediate said chamber in the nozzle and the chamber formed by the piston cylinder, means for introducing combustible fluid into the chamber in the nozzle, and means for forcing air under pressure into and

through said nozzle and into the interior of the piston cylinder.

2. In an engine of the class described, the combination of a piston cylinder provided with an explosion chamber having a main air inlet passage, a piston mounted in the cylinder and adapted to compress air in the explosion chamber, an injection nozzle provided with a chamber having a discharge opening adapted to communicate with the explosion chamber, and provided with a combustible fluid inlet passage adapted to communicate with a source of combustible fluid supply, an air supply passage, communicating with the chamber in the nozzle, a valve in the discharge passage of the nozzle and located intermediate the chamber in the said nozzle and the combustion chamber, means for forcing air under pressure through the nozzle and with the combustible fluid in the nozzle into the explosion chamber in proportions forming a non-explosive mixture thus forced through the discharge opening of the nozzle, valves for opening and closing the respective openings in the nozzle, means for automatically operating said valves, a metallic igniter member having an inwardly projecting lip inside of the explosion chamber in position to receive fluid injected through the nozzle, and an electric sparker embraced within an electric circuit and having terminals inside of the explosion chamber.

3. In an injection nozzle for explosion engines, the combination of a main body portion forming a chamber having a discharge passage and provided with a combustible fluid inlet passage adapted to communicate with a source of fuel supply, and an air supply passage each adapted to communicate with the chamber in the nozzle, a valve stem having a bottom end portion adapted to open and close the discharge passage, an air valve on said valve stem adapted to open and close the air supply passage, and a fuel valve on the same valve stem and movable with the air valve and adapted to close the combustible fluid inlet passage and keep the same closed while the air supply passage and the discharge passage are open, and to open the combustible fluid inlet passage and keep the same open while the air valve and the bottom end of the valve stem are in position to close the air supply passage and discharge passage.

4. In an injection nozzle for explosive engines, the combination of a main body portion forming a chamber having a discharge passage and provided with a combustible fluid inlet passage, and having an air supply passage adapted to communicate with said chamber and with a source of compressed air, a valve stem provided with valves connected therewith for opening and closing said passages respectively, a spring operatively connected with the valve stem and adapted to operate it, and the valves, in one direction to close the air inlet passage and the discharge passage and open the combustible fluid inlet passage, and mechanism for operating the valve stem and thereby said valves in the opposite direction independently of the fluid passing the valves.

5. In an injection nozzle for explosive engines, the combination of a main body portion forming a chamber having a discharge passage and provided with a combustible fluid inlet passage, and having an air supply passage adapted to communicate with said chamber and with a source of air supply, a valve stem provided with valves connected therewith for opening and closing said passages respectively, a spring operatively connected with the valve stem and adapted to operate it and thereby a valve for each of said passages respectively, in one direction, and a movable operating member connected with said valve stem and adapted to positively operate it and thereby the valves connected with the valve stem, in the opposite direction.

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