H. LEMP.

INTERNAL COMBUSTION ENGINE.

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1,076,589. Patented Oct. 21, 1913.

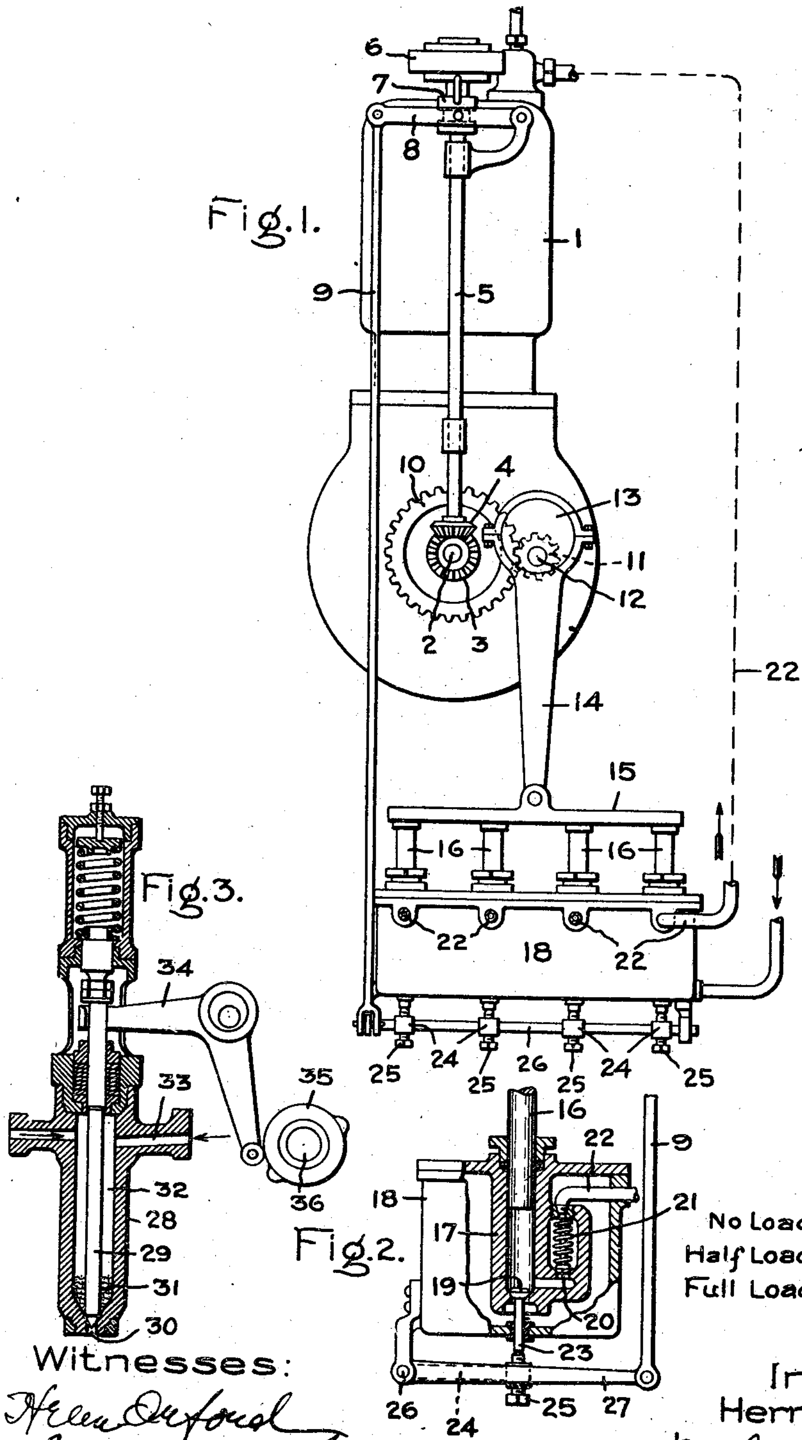

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

No Load	I	O	O	O	O
Half Load	I	I	O	O	O
Full Load	I	I	I	I	I

Witnesses:
Helen Orford
Benjamin B. Hull

Inventor:
Hermann Lemp,
by Albert G. Davis
His Attorney.

UNITED STATES PATENT OFFICE.

HERMANN LEMP, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

INTERNAL-COMBUSTION ENGINE.

1,076,589. Specification of Letters Patent. **Patented Oct. 21, 1913.**

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To all whom it may concern:

Be it known that I, Hermann Lemp, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

The present invention relates to internal combustion engines of the type utilizing heavy oil and in which the temperature of the fluid within the cylinder due to compression is utilized to fire the charge. In such an engine the fuel has to be introduced into the compressed air charge in the cylinder at or about the time the crank reaches its inner dead center. Obviously the fuel pump pressure has to be superior to the compression pressure. It has been the practice up to date in engines of this class to drive the fuel pump at a speed which is only a fractional part of that of the main engine shaft. To this end they are commonly driven by the cam or half-speed shaft.

I have discovered that superior results may be obtained if the fuel pump, instead of being driven at a reduced speed, is driven at a speed considerably greater than that of the engine shaft. To state the matter in another way, the pump instead of being arranged to deliver the full charge of fuel on a given stroke at full load delivers only a portion of said charge, thereby requiring a number of strokes to deliver the full charge. It will, therefore, be seen that my invention is based on the plan of supplying fuel to the engine in successive fractional amounts, increasing the number of said fractional amounts or discharges as the load rises and decreasing them as it falls. The amount of fuel required to operate the engine at no load is substantially one-sixth of that required to operate it at full load. I, therefore, so arrange the pump that its actuator revolves three times as fast as the main engine shaft, or if it be driven by the half-speed cam shaft at six times its speed. Under these conditions it will take six strokes of the pump at full load and but one stroke at no load to fill the cavity immediately preceding the oil inlet valve of the engine, the latter being positively actuated by the cam shaft in the usual manner. The pump piston works at full stroke all the time and at each stroke will deliver fuel or not depending upon the load conditions. To regulate the pump a speed governor driven by the engine is provided that raises its suction valve from the seat when no fuel is required and permits it to seat when fuel is required. In this sense my improved governing mechanism operates on the hit-or-miss plan, the unit of cut-off, however, instead of being the full supply of fuel is as many fractions thereof as is determined by the speed governor. Such an arrangement permits of the use of a small pump of simple construction and insures close regulation at all times and especially at intermediate loads which is a factor of the utmost importance, especially when the engine drives constant speed electric generators. Owing to the arrangement specified the governor can be connected directly to the suction valve operating means thereby reducing the load thereon to such a small value as to prevent lag under load changing conditions. As the load required to be moved by the governor is decreased so also the size of the governor may be decreased and hence the cost of the same. By actuating the suction valve directly from the governor instead of interconnecting it with the pump plunger or some part moving coincidently therewith, I avoid complication, reduce the number of parts and their necessary pivots and joints and also improve the governing by reducing friction.

I have referred above to a single pump in order to simplify the description, but it is to be understood that as many pumps will be provided as there are cylinders to the engine, and that all of the suction valves will be operated at the proper time or times by the speed governor.

In the accompanying drawing which illustrates one of the embodiments of my invention, Figure 1 is a diagrammatic view of an engine and my improved pump mechanism; Fig. 2 is a sectional view of the pump; Fig. 3 is a detailed sectional view of the injector and valve for admitting fuel to the engine; and Fig. 4 is a diagrammatic illustration of the action of each pump.

1 indicates an engine which may have one, two or more cylinders and pistons of usual construction, said pistons being connected to the crank shaft 2 in the usual way. Mounted on the crank shaft is a beveled gear 3

meshing with a similar gear 4 for driving the governor shaft 5. On the upper end of the shaft is a speed governor 6 having a sliding collar 7 whose position is changed by changes in speed of the engine, *i. e.* raised by an increase and lowered by a decrease in speed.

8 indicates a governor lever having pins which engage the collar and transmit motion from the collar to the lever.

9 indicates the governor rod for actuating the suction valve or valves of the pump or pumps as will appear later.

Mounted on the main shaft is a gear 10 that meshes with a gear 11 shown in dotted lines. This latter gear is mounted on a shaft 12 that carries the eccentric 13. The speed relation between the main engine shaft 2 and the eccentric carrying shaft 12 is such that the latter makes three revolutions to one revolution of the former. Surrounding the eccentric is an eccentric strap having a rod 14 that is pivotally connected to the cross-head 15. To the cross-head are connected as many pump plungers 16 as there are pumps. Each of these pumps has a cylinder 17. These cylinders may be formed in a unitary structure or may be separate as desired and are located within a fuel containing tank 18. Each pump is provided with a suction valve 19 located at its lower end and a discharge valve 20 that is normally held against its seat by the coiled compression spring 21. Communicating with each discharge valve is a pipe 22 for conveying fuel from the pump to its corresponding engine cylinder.

Each suction valve is provided with a downwardly extending stem 23 that projects through a suitable stuffing box in the bottom of the tank. Located below each suction valve is an arm 24 best shown in dotted lines, Fig. 2. These arms are provided with set-screws 25 by means of which the throw or movement of the valves can be accurately adjusted. The arms are rigidly mounted on the pivot 26 that is supported by suitable bearings at its end. Mounted on the pivot 26 is a lever 27 the free end of which is connected to the rod 9 leading to the governor lever.

The pump is so proportioned and arranged that if it is in constant effective action, it will pump during one complete cycle of each engine cylinder (four stroke cycle) enough oil to run it under full load conditions, the work, however, being divided into as many strokes as the fuel required for running light is contained in the total amount of fuel required at full load. In the present illustration six working strokes of each pump plunger are required for each engine cylinder, when the latter is working at full load. The relation of the speed governor and the suction valves is such that they are operated simultaneously. That is to say, the speed governor either raises all of the valves or permits them to close.

In Fig. 4 is illustrated diagrammatically the operation of a pump. The short vertical lines represent the effective pump strokes and the circles non-effective pump strokes. That is to say, in the first instance the suction valve 19 is supposed to be closed and in the latter instance, to be open. In the upper row in said figure, marked "No Load" one short line is shown and five circles, indicating that for each firing stroke of an engine cylinder the pump plunger makes one effective and five ineffective strokes. In the second line is shown three short vertical lines and three circles. This is the half load condition and means that the suction valve 19 is closed for three strokes of the pump plunger and is open for three. In the last line of said figure is illustrated the full load condition. Six short vertical lines are shown indicating that plunger is making six effective strokes for each firing stroke of the engine, the suction valves 19 being closed on all of the downward strokes of the pump plunger.

For simplicity I have described only the action of one pump, but it is evident that all pumps operate in the same manner. For loads immediate those specified the number of effective pump strokes for firing the engine will be changed.

In Fig. 3 is shown a casing 28 that is located in the head of each cylinder. This casing contains a needle valve 29 for admitting fuel under compressed air pressure through the nozzle 30 to the cylinder of the engine. Surrounding the needle valve are fine meshed screens or other devices 31 to insure proper mixing of the fuel and air. Between the needle valve and the inner wall of the casing is a chamber or cavity 32 to which fuel is admitted by the pipe 22 from the pump, it being understood that as many of these casings and needle valves are provided as there are engine cylinders. 33 indicates a passage for admitting compressed air from a suitable tank, the latter being supplied by an air compressor. This air should be under a pressure greater than that of the compression pressure within the engine cylinder. The needle valve is operated by a lever 34 and a cam 35 driven by a cam or half speed shaft 36 in the manner commonly employed in engines of this class.

In the operation of my invention the pumps will have anything from one to six effective piston strokes to each firing stroke of the engine depending upon the position of the speed governor, as determined by the load conditions. The fuel from each pump is forced into the cavity or chamber 32 where it remains until the cam 35 reaches a predetermined position when said cam actuates the lever 34 which in turn raises the needle valve 29 and permits compressed air from the storage tank to force it into the cylinder. Owing to the high compression pressure within the cylinder the charge of fuel whether it be due to one stroke or six of the pump, is immediately fired due to the high temperature of the compressed air or other gas within the cylinder.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is:—

1. An internal combustion engine in combination with a fuel pump capable of displacing on each working stroke only a fractional part of the amount of fuel required by the engine at full load and arranged to deliver one or more fractional fuel charges to the engine for each firing stroke of the latter, means for driving the pump, and a governing means that determines whether the pump shall deliver one or more of such fractional fuel charges for each firing stroke of the engine.

2. An internal combustion engine in combination with a pump for supplying fuel thereto comprising a cylinder, a plunger which is driven by the engine at a speed greater than that of said engine, said plunger displacing on each working stroke only a fractional part of the fuel required by the engine at full load, a suction valve for the pump, and a speed governor driven by the engine which controls the seating of said valve.

3. An internal combustion engine in combination with a fuel pump therefor comprising a cylinder, a plunger, a means actuated by the engine for imparting to the plunger a plurality of strokes for each firing stroke of the engine, suction and discharge valves for the pump, a speed governor driven by the engine, and a means moved by the governor which controls the action of the suction valve, said means being independent in its movements of the plunger actuating means.

4. An internal combustion engine in combination with a pump for supplying fuel thereto which is proportioned and arranged to deliver to the engine at each pump stroke an amount of fuel substantially equal to that required for minimum load operation, means for driving the pump at such speed that at maximum load the pump will deliver to the engine for each firing stroke an amount of fuel corresponding to the load by a succession of strokes, and a speed governor that causes the pump to deliver one or more fractional charges of fuel to the engine depending upon the load.

5. An internal combustion engine in combination with a pump for supplying fuel thereto by successive strokes for each firing stroke of the engine, the amount of fuel delivered at each stroke being substantially the amount required for minimum load conditions of the engine, engine driven gearing for imparting to the pump plunger a number of strokes in excess of the number of firing strokes of the engine, suction and discharge valves for the pump, and a speed governor acting on the suction valve in a manner to cause one or more of the pump strokes to be effective in delivering fuel to the engine depending on the load.

6. A multiple cylinder internal combustion engine, in combination with a multiple plunger pump for supplying fuel thereto by successive strokes for each firing stroke of the engine, the amount of fuel delivered at each plunger stroke being substantially the amount required for minimum load conditions on the engine, means driven by the engine for imparting to the plungers a number of strokes in excess of the number of firing strokes of the engine, suction and discharge valves for each pump plunger, means for moving all of the suction valves, and a governor for actuating said means.

7. An internal combustion engine having a fuel receiving chamber opening into the cylinder, in combination with a pump for supplying to the chamber on each working stroke an amount of fuel substantially equal to that required for minimum load operation of the engine, means for imparting to the pump plunger a plurality of strokes for each firing stroke of the engine, suction and discharge valves for the pump, a speed governor for opening and closing the suction valve as the load changes to cause the pump to deliver one or more fractional fuel charges to the chamber, and a valve which admits fuel to the engine cylinder from the chamber.

In witness whereof, I have hereunto set my hand this 20th day of January, 1912.

HERMANN LEMP.

Witnesses:
HELEN ORFORD,
BENJAMIN B. HULL.