Dec. 29, 1959 M. R. GUIOT 2,918,911

DEVICE FOR INJECTING FLUID INTO INTERNAL COMBUSTION ENGINES

Filed Jan. 2, 1958 5 Sheets-Sheet 1

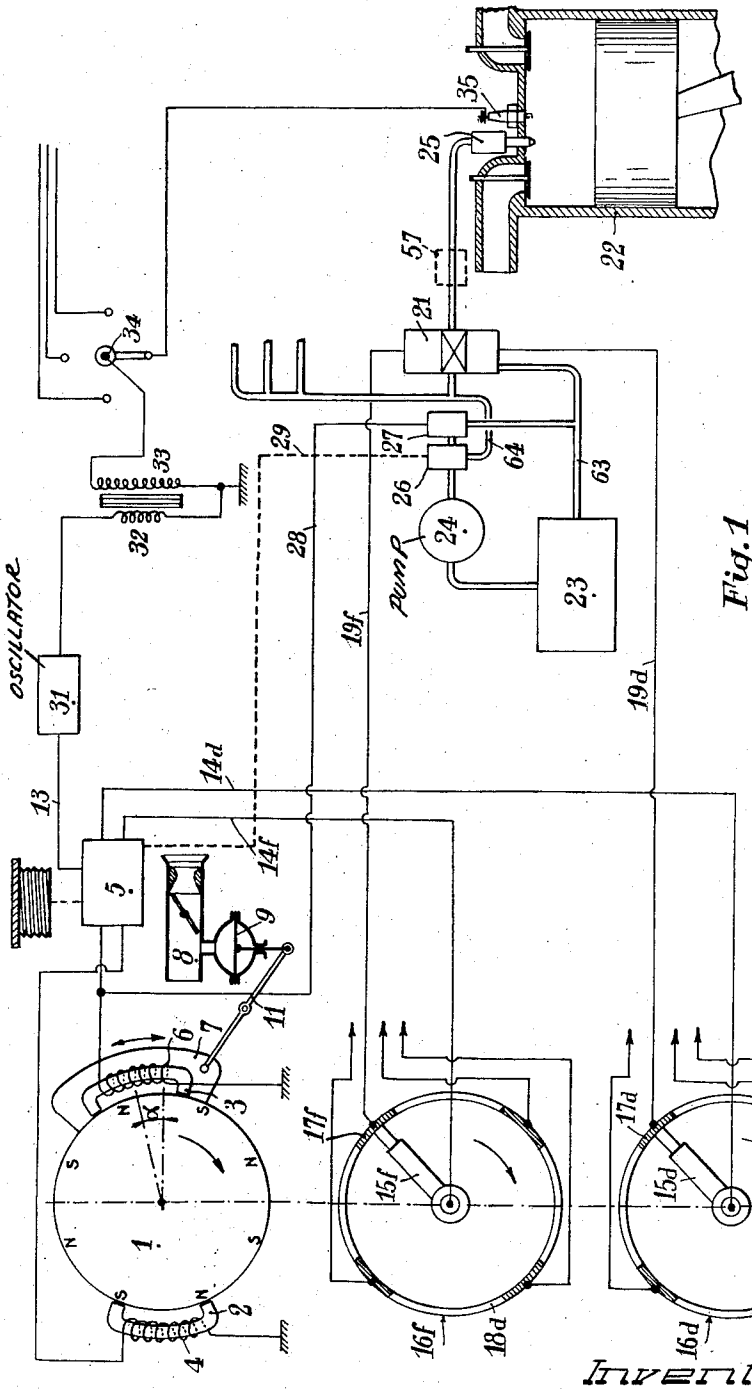


Fig. 1

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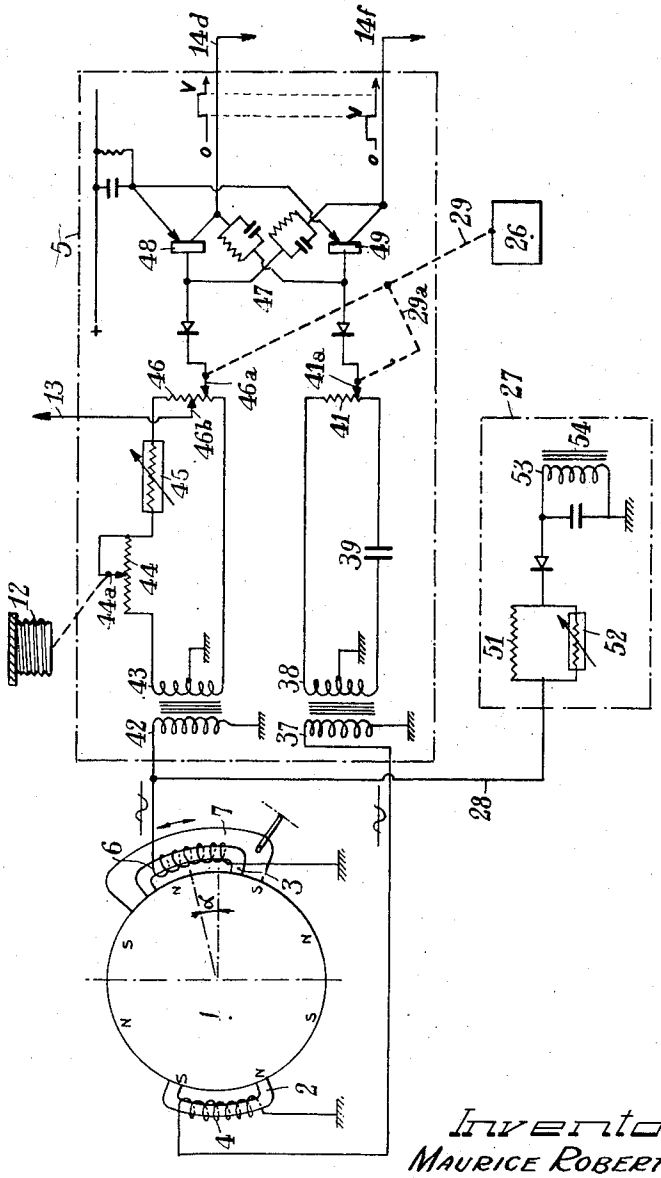
by Kill, Sherman, Merriam, Morsa & Simpson Attys.

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DEVICE FOR INJECTING FLUID INTO INTERNAL COMBUSTION ENGINES

Filed Jan. 2, 1958 5 Sheets-Sheet 2

Fig. 2



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DEVICE FOR INJECTING FLUID INTO INTERNAL COMBUSTION ENGINES

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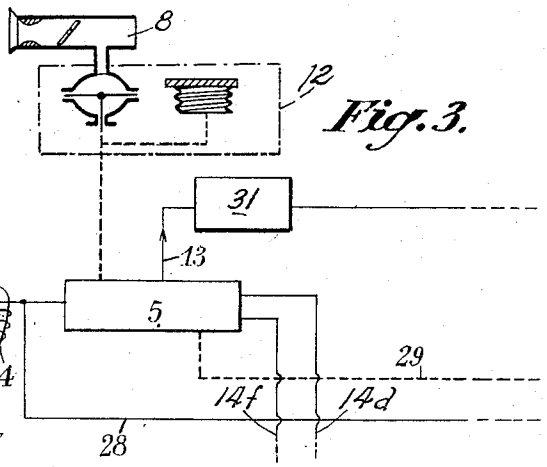


Fig. 3.

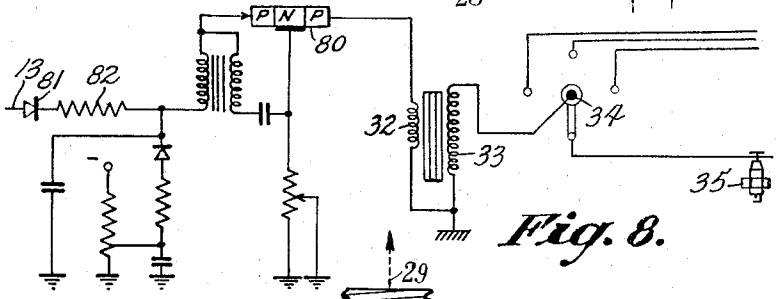


Fig. 8.

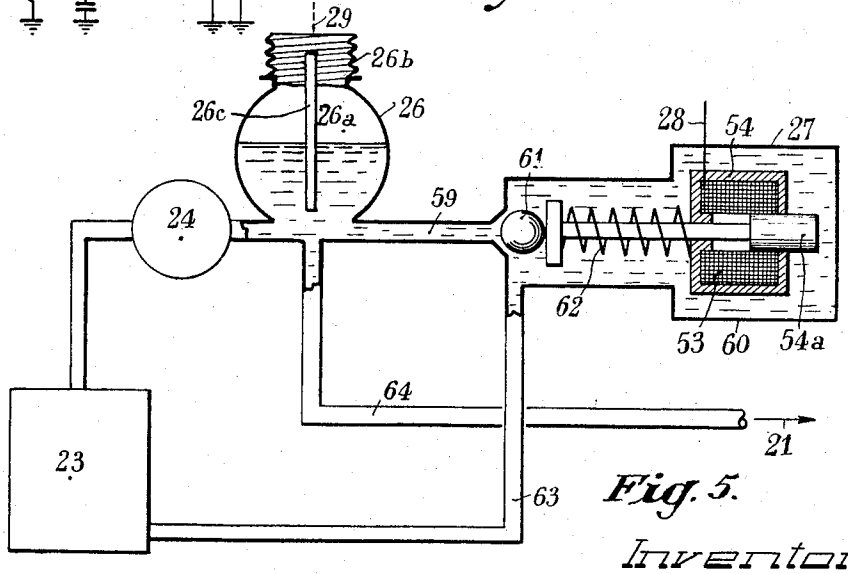


Fig. 5.

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DEVICE FOR INJECTING FLUID INTO INTERNAL COMBUSTION ENGINES

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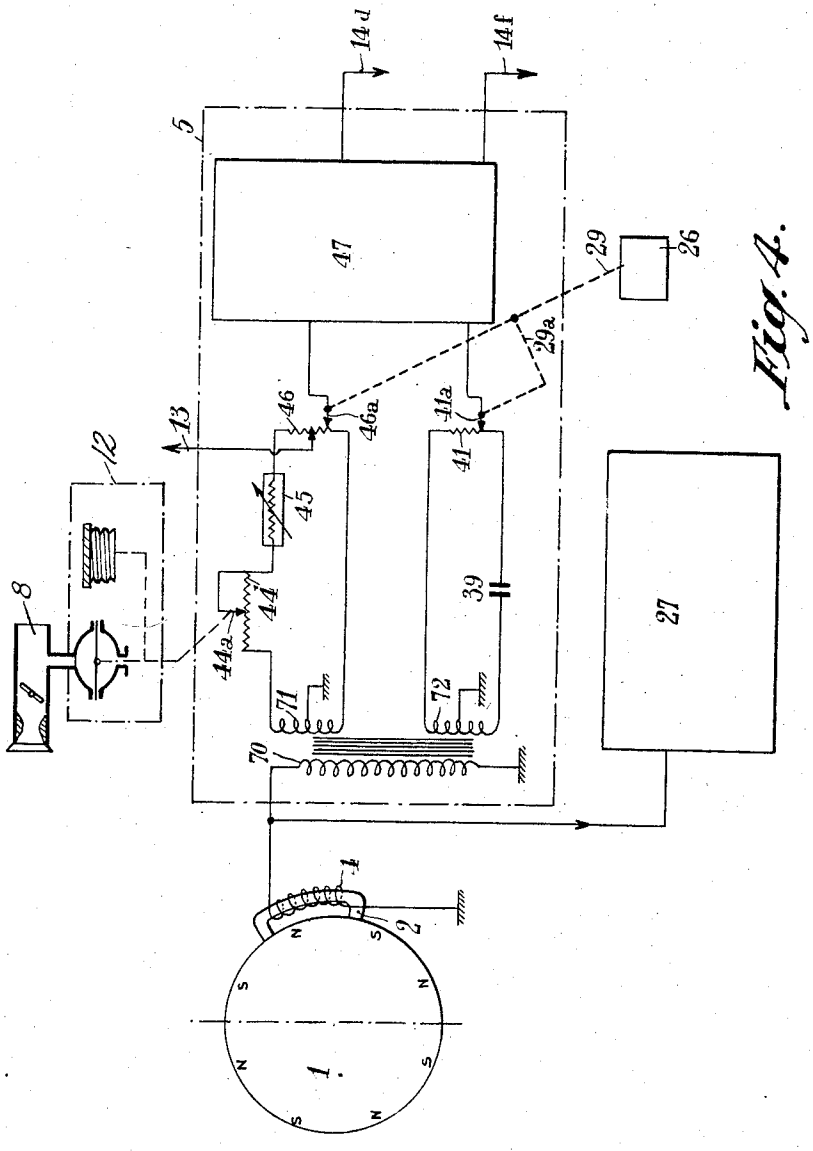


Fig. 4.

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DEVICE FOR INJECTING FLUID INTO INTERNAL COMBUSTION ENGINES

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Fig. 6

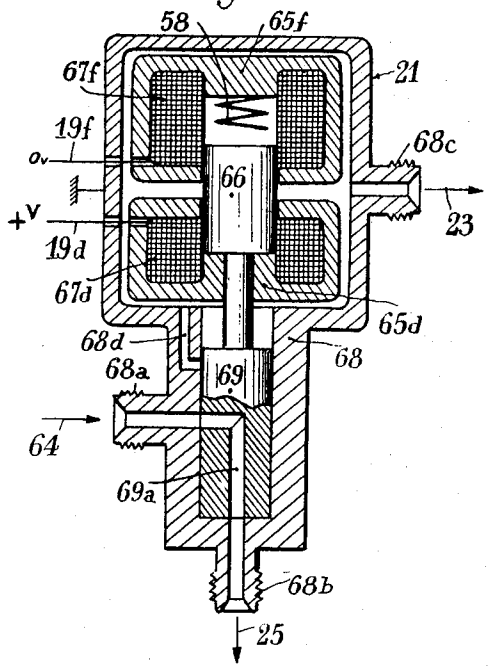
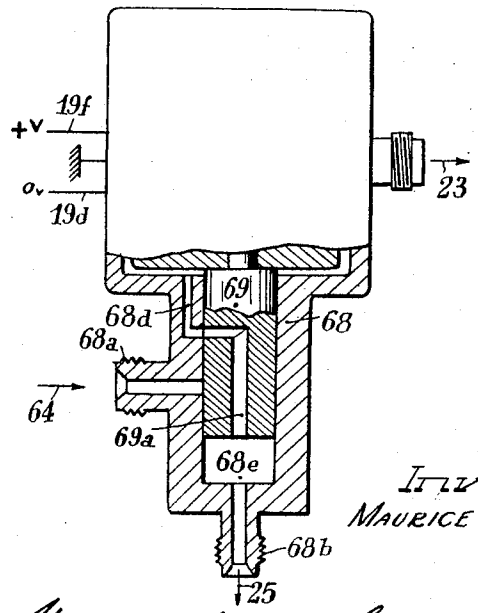


Fig. 7



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United States Patent Office 2,918,911
Patented Dec. 29, 1959

2,918,911

DEVICE FOR INJECTING FLUID INTO INTERNAL COMBUSTION ENGINES

Maurice Robert Guiot, Paris, France, assignor to Weselco Limited, Toronto, Ontario, Canada, a corporation of Canada

Application January 2, 1958, Serial No. 706,835

27 Claims. (Cl. 123—32)

This invention relates to devices for injecting fuel or other fluids into internal combustion engines.

Hitherto known injection devices require a high-precision and therefore costly equipment.

On the other hand, the adjustment of these known injection devices is extremely delicate, due to the lack of flexibility, independence and continuity of the adjustment and control means comprising as a rule parts the dimensions of which are rigidly determined by construction, although their contours are sometimes determined rather empirically.

It is the essential object of the present invention to provide an injection control device adapted to avoid the drawbacks broadly set forth hereabove.

To this end, the device according to this invention for injecting fuel or other fluids into internal combustion engines comprises means for generating oscillations the frequency and amplitude of which are proportional to the velocity of rotation of the engine, means for generating pulses from these oscillations which are subsequently fed to two parallel circuits for controlling the opening and closing of the injectors, said pulses being phase-shifted with one another as a function of various parameters, notably the vacuum obtaining in the induction manifold, the engine speed and the injection pressure, whereby the beginning and the end of the injection are properly timed in relation to the engine cycle of operation for all current values of the various parameters involved.

The hydraulic circuit of the injection device comprises a high-pressure pump, a pressure-compensating device mounted at the delivery side of this pump, a pressure-regulating device adapted to stabilize and adapt the injection pressure to the different engine speeds, and a plurality of pulsating solenoid valves each adapted to feed a separate injector.

These pulsating solenoid valves comprise each an opening electromagnet and a closing electromagnet, both electromagnets having a common plunger and being alternately energized by opening and closing pulses.

The oscillation generator consists of a core rotatably driven at a speed proportional to the engine speed and comprising at its outer peripheral portion a number of alternate magnetic poles, and at least one magnetic circuit carrying a coil winding in which the oscillations are generated.

According to a first form of embodiment, one of the magnetic circuits is carried by a disk rotatably movable about the core axis, the other magnetic circuit being stationary; the movable magnetic circuit is adapted to be angularly displaced relative to the stationary magnetic circuit through an angle varying in proportion to the value of the vacuum obtaining in the induction manifold, thus determining the quantity of injected fluid.

According to an alternate form of embodiment the oscillation generator comprises a single fixed magnetic circuit, the oscillations generated in this circuit being subsequently phase-shifted by electric means as a function of the vacuum existing in the induction manifold.

The oscillation generator feeds oscillations to an injection regulator in which these oscillations are phase-shifted by electric means as a function of the different parameters cited hereinabove.

These oscillations are also fed from the generator to the pressure regulator the correcting action of which is subordinate to the injection requirements.

According to a first form of embodiment of the oscillation generator the injection regulator comprises two parallel circuits fed from the two outputs of the oscillation generator. The first circuit comprises phase-shifting means adapted to impart a lead to the oscillations, notably as a function of the engine speed and of the injection pressure. The other circuit connected to the stationary magnetic circuit receives moderately phase-shifted oscillations.

The outputs of these two magnetic circuits are fed to the two input terminals of a monostable multvibrator having its two outputs connected to the two parallel circuits for opening and closing the injectors.

In the case of a spark-ignition engine an electronic or electromechanical ignition system is controlled by the phase-shifted oscillations derived from the first circuit of the injection regulator.

According to a specific form of embodiment of this invention, the first injection regulating circuit may comprise a transformer secondary having a grounded center tap; this secondary is connected in series with a first potentiometer, a thermistor and another potentiometer. The function of the thermistor is to produce a phase displacement subordinate to the oscillation frequency, that is, to the engine speed. The position of the slider of the first potentiometer introduces an additional phase displacement depending on the density and temperature of the surrounding atmosphere. Finally, the other potentiometer may comprise two sliders connected the one to the ignition system and the other to one input terminal of the monostable multivibrator.

Thus, in the case of a spark-ignition engine, a well-defined time relationship is obtained between the pulses controlling the beginning of the injection and those controlling the ignition.

The slider of the other potentiometer which is connected to the first input of the multivibrator may be controlled from the injection pressure compensating device, so that the beginning time of the injection may be varied as a function of the pressure and possibly as a function of the temperature of the injected fluid.

In certain cases it is also possible to contemplate the phase shifting of the oscillations fed to the other circuit of the injection regulator as a function of the injection pressure, with the consequence that the end of the injection is also displaced in the time.

According to another typical embodiment of the oscillation generator the oscillations collected from the single output of this generator are fed to the primary of a transformer having its two secondaries provided with grounded center taps and connected to the two phase-shifting circuits of the injection regulator.

In this case the slider of the first potentiometer of the first circuit is also displaced as a function of the vacuum obtaining in the induction pipe.

The device according to this invention is applicable notably to any internal combustion piston engine wherein the injected fluid is introduced either directly into the combustion chamber or outside this combustion chamber by external injection into the air-intake or induction manifold.

This device is suitable for use with any conventional injectors, whether of the needle, split or turbulence type.

In order to afford a clearer understanding of this invention and of the manner in which the same may be

embodied in the practice, reference will now be made to the attached drawings forming part of this specification and illustrating diagrammatically by way of example a few typical embodiments of the present invention. In the drawings:

Figure 1 is a diagram illustrating the basic principle of the injection device according to this invention;

Figure 2 is a wiring diagram illustrating the arrangement of the control and regulating device according to this first embodiment;

Figure 3 is another diagram illustrating the principle of a modified embodiment of a control and regulating device constructed in accordance with the teachings of this invention;

Figure 4 is a wiring diagram of the same embodiment;

Figure 5 is a fragmentary diagram of the hydraulic circuit comprising notably the regulator and the injection pressure compensator;

Figure 6 is a longitudinal axial section illustrating a solenoid valve for feeding fluid to the injectors of the type utilized in the device of this invention, this valve being in its open position;

Figure 7 is a longitudinal axial section illustrating the same valve in its closed position; and

Figure 8 is a wiring diagram illustrating a known transistor oscillator included in the ignition system.

In Figure 1 the oscillation generator comprises a core 1 of circular, spider or other adequate form, having in this example eight alternate north-south poles disposed at spaced intervals at its outer periphery. This core 1 is rotatably driven in the clockwise direction at a velocity proportional to the engine speed. In the example described hereafter the injection device according to this invention is assumed to equip a four-cylindered, four-stroke engine. Consequently, the velocity of rotation of the core 1 is half the engine speed. The north-south poles move past pole pieces of two magnetic circuits 2, 3 which in their inoperative positions are spaced 180° apart. The magnetic circuit 2 is stationary and carries a coil winding 4 having one end grounded and the other end connected to one input terminal of an injection regulator 5 shown in block form.

The magnetic circuit 3 carries similarly a winding coil 6 having one end grounded and the other end connected to another input terminal of the regulator 5. The magnetic circuit 3 and winding 6 are mounted on a plate 7 angularly movable about the axis of core 1. The angular displacement of this plate 7 is a function of the vacuum obtaining in the induction manifold 8 of the engine. This vacuum controls for example through a diaphragm 9 and a rocker arm 11 the angular movement of plate 7. Thus, the magnetic circuit 3 and winding 6 may be shifted angularly, relative to the magnetic circuit 2 and winding 4, through an angle α which is a function of the vacuum obtaining in the induction manifold 8.

A corrector 12 is also connected to one input terminal of regulator 5. This corrector is designed to modify the operation of the regulator 5 as a function of various parameters such as the air density and temperature.

Connected to the regulator 5 are three output conductors, that is, a conductor 13 adapted, in the case of a spark-ignition engine, to feed an ignition system, and conductors 14*d*, 14*f* controlling in parallel the beginning and the end of the injection.

These conductors 14*d* and 14*f* are connected to the contact arms 15*d*, 15*f* respectively of injection distributors 16*d*, 16*f*. These contact arms 15*d*, 15*f* are rotatably driven at the same velocity as core 1 and adapted to contact conducting segments 17*d*, 17*f* respectively which are separated by insulating segments 18*d*, 18*f*. Each conducting segment 17*d*, 17*f* is connected through a conductor 19*d*, 19*f* to the pair of input terminals of a pulsating solenoid valve 21 controlling the supply of fuel or like fluid to the corresponding engine cylinder 22.

The injection circuit proper comprises a fuel tank 23, a high-pressure pump 24 delivering fuel to the different injectors 25 through an injection-pressure compensator 26. On the other hand, the pressure regulating device 27 controlling the injection pressure is connected through a conductor 28 to the coil winding 6. The output of pressure compensator 26 is connected in parallel through a pipe line 64 to the different pulsating solenoid valves 21 corresponding to the various engine cylinders 22.

The pressure compensator 26 controls through a connection 29 the injection device 5.

In the case of a spark-ignition engine the conductor 13 is connected to an electronic or electromechanical ignition system comprising for example an oscillator 31 the output of which delivers current pulses to the primary 32 of a step-up transformer. The secondary 33 of this transformer is connected to the contact arm of a distributor 34 through which sparks are delivered sequentially to spark plugs 35.

Now reference will be made of Fig. 2 illustrating the wiring diagram of the injection regulator and injection pressure regulators 5, 27.

In this diagram the coil winding 4 carried by the magnetic circuit 2 is connected to the primary 37 of a transformer having its secondary 38 connected in series with a capacitor 39 and a potentiometer 41, the center tap of this secondary being grounded.

Likewise the coil winding 6 is connected to the primary 42 of another transformer having its secondary 43 mounted in series with a potentionmeter 44, a thermistor 45 and another potentiometer 46, the center tap of this transformer being also grounded.

The slider 41*a* of potentiometer 41 is connected to one input terminal of monostable multivibrator 47.

This monostable multivibrator 47 comprises two transistors 48 and 49. The slider 46*a* of potentiometer 46 is connected to the other input of the monostable multivibrator 47.

The aforesaid conductors 14*d* and 14*f* are connected to the pair of output terminals of the monostable multivibrator 47 respectively, that is, to the pair of collector electrodes of transistors 48 and 49.

The potentiometer 46 is also provided with another slider 46*b* connected to conductor 13. The position of the slider 44*a* of potentiometer 44 is controlled by the corrector 12.

The pressure regulator 27 connected through a conductor 28 to the coil winding 6 comprises a parallel assembly comprising a resistor 51 and a thermistor 52, this assembly being in series with the winding 53 of an electromagnet 54 the purpose of which will be described more in detail presently.

The operation of the injection device illustrated diagrammatically in Figs. 1 and 2 is as follows:

When the internal combustion engine is running, the core 1 rotatably driven therefrom generates oscillations in the coil windings 4, 6 at a frequency and an amplitude increasing linearly with the rotational speed of the engine. The oscillations produced in the winding 6 are phase-shifted in relation to those produced in the winding 4 through an angle α depending on the vacuum obtaining in the induction manifold 8. In fact, this vacuum is used to control the angular displacement of the plate 7 about the axis of rotation of the core 1, as already explained.

The oscillations flowing through the winding 6 are fed to the first input terminal of regulator 5, that is, to the primary 42, and also to the winding 53 of pressure regulator 27.

The oscillations collected in the secondary 43 are fed to the potentiometers 44, 46 and also to the thermistor 45. As the oscillation amplitude increases linearly with the engine speed, this thermistor 45 will introduce a phase displacement in these oscillations which is a function of the engine speed. Thus, oscillations having an

advance increasing with the engine speed are obtained across the terminals of potentiometer **46**.

The slider **46***b* receives oscillations fed through the conductor **13** to control the operation of the oscillator **31** with an advance subordinate to the engine speed.

The slider **46***a* is also fed with similarly phase-shifted oscillations applied to the first input terminal of the monotable multivibrator **47** which is connected to the base of transistor **48**.

The corrector **12** acting on the slider **44***a* of potentiometer **44** acts as a means for correcting the phase-shifting of these oscillations as a function of the air temperature and density.

The oscillations fed to the other input terminal of regulator **5**, that is, to the primary **37**, are transmitted through the secondary **38** to the end terminals of potentiometer **41**. These oscillations are fed through the slider **41***a* to the other input terminal of the monostable multivibrator **47**, that is, the terminal connected to the base electrode of transistor **49**.

Of course, any other suitable means may be used for controlling the monostable multivibrator **47**, for example input terminals connected to the emitter electrodes of transistors **48**, **49**.

The position of slider **46***b* which determines the ignition lead may be adjusted either manually, or automatically as a function of any other parameters.

Besides, the position of sliders **41***a* and **46***a* may be adjusted at will either manually or automatically. Figure 2 illustrates a diagrammatic connection **29** through which the injection pressure compensator **26** controls the slider **46***a* to vary the phase-displacement of the oscillations fed to the first input terminal of the monostable multivibrator **47** as a function of pressure variations. If desired, an auxiliary connection **29***a* acting on the slider **41***a* may also be provided, for example in the case of a diesel engine in which the injection end time may vary as a function of the injection pressure.

Thus, to sum up, the first input terminal of the monostable multivibrator **47** is fed with oscillations having an advance subordinate to the following parameters: Vacuum in the induction manifold (through plate **7**), engine speed (thermistor **45**) air density and temperature (potentiometer **44**), injection pressure (slider **46***a*). The other input terminal of the monostable multivibrator **47** is fed with oscillations having a moderate phase-shift (through slider **41***a*).

The monostable multivibrator **47** supplies the conductors **14***d*, **14***f* for the beginning and end times of the injection respectively with rectangular pulses of opposite polarities. Only the negative alternations of the oscillations fed to the two inputs are effective to operate the monostable multivibrator **47**. When a leading negative alternation is fed to the base electrode of transistor **48**, it releases the latter while blocking the transistor **49**, so that the conductor **14***d* controlling the beginning of the injection is brought to a +V (volts) potential. At the same time the conductor **14***f* controlling the end of the injection is substantially at 0 volt potential. When a negative alternation is fed to the base electrode of transistor **49** with a certain time lag relative to the preceding one, this transistor is released and the other transistor **48** is blocked automatically. Consequently, the potential of conductor **14***f* controlling the end of the injection will raise in turn to the aforesaid +volts value, whereas the potential of conductor **14***d* controlling the beginning of the injection drops again to 0 volt.

The rectangular pulses collected in conductors **14***d* and **14***f* are fed through the injection distributors **16***d*, **16***f* respectively to the two opening and closing input terminals of the pulsating solenoid valves **21**. The injection time obtaining in each cylinder is therefore a function of the duration of the pulse flowing through the conductor **14***d* controlling the beginning of the injection; in other words, this injection time is a function of the time-lag between two negative alternations occurring at the input terminals of the monostable multivibrator **47**.

Besides, as the oscillations delivered from the sliders **46***a* and **46***b* are phase-shifted with one another through an angle depending on their positions, the ignition timing is also shifted with precision relative to the beginning of the injection.

Figure 8 illustrates a wiring diagram of a known transistor oscillator adapted to be incorporated in the ignition system.

In this figure, the oscillator comprises a transistor **80** of the PNP junction type. This transistor is normally blocked by properly selecting the bias voltage of its emitter and base electrodes. The positive release pulses fed to conductor **13** are transmitted through a diode **81** and a resistor **82** to the emitter electrode of transistor **80**. By adequately selecting the value of resistor **82**, it is possible to determine once for ever the level at which the oscillator will become operative. Thus, the transistor oscillator emits trains of oscillations which are fed to the primary **32** of the step-up transformer.

Now the function and operation of the regulator **27** and compensator **26** of the injection pressure will be described more in details with reference more particularly to Fig. 5.

In this figure the injection pressure compensator **26** consists of a vessel partly filled with fuel. The space **26***a* overlying the fluid level is filled with an inert gas under pressure, for example nitrogen. At the upper portion of this vessel a pressure-responsive device **26***b* is provided which acts through a connection **29** to control the regulator **5** as a function of the fuel injection pressure. A thermal rod **26***c* immersed in the fuel contained in the vessel **26** is connected to the pressure-responsive device **26***b* so as to control jointly therewith the connection **29** according to fuel temperature variations.

This compensator **26** is effective to maintain the fuel injection pressure in case of sudden output variations. In fact, this injection pressure is controlled from the pressure regulator **27** and is closely dependent on the amplitude of the oscillations generated in the winding **6**, that is, on the engine speed.

This pressure regulator **27** consists of an electromagnet **54** having a plunger **54***a* disposed within a case **60**. A valve member **61** is unseated by the pressure of the fuel delivered from the pump **24** through the pipe line **64** from the solenoid valve **21**. The fuel pressure action is partly compensated by a return spring **62** urging the valve member **61** to its seated position to close the pipe line **59**, the correction being effected by the attraction of the plunger **54***a* when the winding **53** is energized.

In the position illustrated in Fig. 5 one portion of the fluid delivered by the pump **24** is returned directly to the fuel tank **23** through the return line **63**. Consequently, the pressure in the pipe line **64** depends on this quantity of fuel, on the force of the return spring **62** and on the value of the energization of winding **53**. Now this winding **53** (see Fig. 2) is connected to the winding **6** through the assembly comprising the resistor **51** and thermistor **52** in parallel. Due to the resistance curve as a function of the thermistor voltage, the energizing voltage applied to the winding **53** may be governed by any suitable law according to fuel injection requirements.

In Figs. 6 and 7 of the drawings the pulsating solenoid valve **21** illustrated consists essentially of a pair of electromagnets **65***d*, **65***f* having a common plunger **66**. These electromagnets may be of the type known under the trade name of "Selenoid." The windings **67***d* and **67***f* of these electromagnets are connected to conductors **19***d* and **19***f* respectively. The same electromagnets **65***d* and **65***f* are disposed inside a common body **68** comprising an inlet **68***a* for the fluid under pressure which is connected to the pipe line **64**, an outlet **68***b* for the fluid under pressure which leads to the injector **25**, and another outlet **68***c*

constituting the return line to the tank 23. The axially movable plunger 66 is solid with a slide-valve distributor 69 in which a duct 69*a* is formed, as shown. A passage 68*d* connects the chamber in which the slide valve 69 is slidably mounted to the chamber in which the electromagnets are mounted.

When the conductor 19*d* is brought to a potential +V (volts), the winding 67*d* controlling the beginning of the injection phase is energized and attracts the core 66 downwards, that is, to the position shown in Fig. 6 which is the open position of the solenoid valve 21. In this position the duct 69*a* connects the high-pressure line 64 with the relevant injector 25.

When at the end of the injection process, the conductor 19*f* is brought in turn to the potential +V (volts) as conductor 19*d* resumes the ground potential, the winding 67*d* is de-energized whereas the winding 67*f* becomes energized. The plunger 66 is attracted upwards as well as the slide valve 69 solid therewith which takes the position in which it is shown in Fig. 7.

The above-described solenoid valve is characterized by many advantageous features. Firstly, when the electromagnet 67*d* controlling the beginning of the injection process is energized, the descending slide valve 69 acts as a piston and injects the fuel contained in the lower chamber 68*e* formed between the lower end of the piston-forming slide valve and the bottom of the body 68, thus developing a preliminary shock wave in the duct leading to the injector 25. This shock wave will on the one hand lift the needle in case of a needle-type injector, and on the other hand force the injection pressure during the initial phase of the injection period. Then, when the slide valve 69 has attained its lowermost position (Fig. 6) the constant injection pressure is established and maintained throughout the injection period.

When the solenoid valve 21 is closed, the ascending movement of the slide valve 69 exerts a suction on the fuel contained in the duct leading to the injector 25, thereby preventing the latter from leaking into the relevant engine cylinder.

The chamber 68*e* can be filled through the duct 68*d* communicating with the aforesaid chamber 68*e* through the duct 69*a*. In this case a spring 58 moves the assembly 66—69 through a distance sufficient to close the communication 68*d*—69*a* so that in case the electromagnet 65*f* were not energized the duct 68*d* will be closed to prevent the occurrence of any leak.

In the modified embodiment of the injection device according to this invention which is illustrated in Figs. 3 and 4 of the drawings the oscillation generator comprises only one magnetic circuit 2 carrying the winding 4. The oscillations generated in this winding 4 are fed to the injection regulator 5 and also to the conductor 28 leading to the injection pressure regulator.

These oscillations are applied to the primary winding 70 of a transformer comprising two secondary windings 71, 72 having grounded center taps. The potentiometers 44, 46 and thermistor 45 are connected in series to the secondary 71, and the potentiometer 41 is connected to the other secondary 72.

In this specific embodiment the vacuum created in the induction manifold 3 controls the corrector 12 acting in turn on the slider 44*a* of potentiometer 44. This corrector 12 is also responsive as in the first case to the parameters such as air density and temperature.

In this modified embodiment the phase displacement produced by the vacuum in the induction manifold is used to control electric means instead of the mechanical means of the first form of embodiment. The other component elements of regulator 5 are similar to those already described and are therefore designated by the same reference numerals.

Although the above description and attached drawings refer mainly to the application of the injection device of this invention to a spark-ignition, four-stroke, four-cylindered engine, it will be readily understood by anybody conversant with the art that this device is also applicable to any system requiring a periodic fluid-metering operation, and that many modifications may be brought to these exemplary embodiments without departing from the spirit and scope of this invention as set forth in the appended claims.

What I claim is:

1. A device for injecting a fluid into internal combustion engines which comprises at least one injector, means for supplying said injectors with a fluid under pressure, a first electric opening circuit acting on said means to feed said injectors when said first opening circuit is actuated, another electric closing circuit acting on said means to discontinue the supply of fluid to said injectors when said other circuit is actuated, means for generating oscillations the frequency and amplitude of which are proportional to the velocity of rotation of the engine, means for phase-shifting said oscillations with one another as a function of the vacuum in the induction manifold, the engine speed, the injection pressure and the air density and temperature, and other means for generating from said phase-shifted oscillations control pulses fed to said first and second electric circuits, whereby the beginning and the end of the injection period take place at proper moments of the cycle of rotation of the engine.

2. Injection device for internal combustion engines, comprising at least one injector, a fluid tank, a high-pressure pump fed from said tank, pressure-compensating means for maintaining the injection pressure to a constant value during sudden variations in the fluid output, a plurality of pulsating solenoid valves having a first control inlet and a second control inlet, said solenoid valves being connected in parallel to said pump and controlling each a separate injector, a first electric opening circuit connected to the first inlet of said solenoid valves, another electric closing circuit connected to the other inlet of said solenoid valves, means for generating oscillations the frequency and amplitude of which are proportional to the velocity of rotation of the engine, means for adjusting the injection pressure as a function of the engine speed by means of said oscillations, means for phase-displacing said oscillations as a function of the vacuum obtaining in the induction manifold, the engine speed, the injection pressure and the air density and temperature, and other means for generating from said oscillations control pulses acting on said first and second electric circuits, said pulses controlling the opening and closing of said pulsating solenoid valves respectively.

3. An injection device as set forth in claim 2, comprising a return circuit leading from the delivery side of said high-pressure pump to said tank, means for variably obturating said return circuit, an electromagnet controlling said obturating means to vary the fluid pressure at the delivery side of said pump, an electric network connected across said oscillation generator and said electromagnet so as to feed thereto an energizing voltage consistent with the oscillation frequency, said voltage varying as a function of the engine speed according to a predetermined law consistent with the injection requirements, said law being determined after the transfer characteristic of the electric network.

4. An injection device as set forth in claim 3, wherein said electric network consists of a resistance and a thermistor connected in parallel.

5. A device as set forth in claim 2, wherein each pulsating solenoid valve comprises a body formed with a high-pressure fluid inlet connected to said pump, a fluid outlet connected to said injector and a return outlet leading to said tank, an opening electromagnet and a closing electromagnet mounted in said body, said electromagnets being connected to the two control input terminals of said solenoid valve respectively, and axially movable plunger common to both electromagnets, a cylindrical cavity in said body which is limited by a side wall and a bottom, a slide valve solid with said plunger and axially mov-

able in said cavity, said high-pressure fluid inlet opening into said side wall of said cavity and said injector-feeding fluid outlet being connected with the bottom of said cavity, said slide valve being adapted to connect said high-pressure fluid inlet with said fluid outlet connected to said injector when said opening electromagnet alone is energized, and discontinuing said connection when said closing electromagnet alone is energized, said slide valve also acting as a piston to on the one hand force any fluid present from the chamber formed between said slide valve and said bottom of said cavity towards said injector when said opening electromagnet is energized and attracts said plunger, and on the other hand exhaust any fluid remaining in the outlet connected to said injector when said closing electromagnet is energized in turn, to prevent said injector from leaking into the engine cylinder associated therewith.

6. Injection device as set forth in claim 5, wherein said slide valve in its closed position causes the chamber formed between said slide valve and said bottom of said cavity to communicate with said outlet leading to said tank in order constantly to keep said chamber filled with fluid.

7. Injection device as set forth in claim 6, wherein return means are provided so that when none of said opening and closing electromagnets is energized said slide valve will discontinue any communication between said high-pressure fluid inlet and the outlet connected to said injector, on the one hand, and between said return outlet leading to said reservoir and the outlet connected to said injector, on the other hand.

8. Injection device as set forth in claim 2, wherein said means for generating oscillations comprise a core rotatably driven at a velocity proportional to the engine speed, a plurality of alternate magnetic poles disposed at spaced intervals around the outer periphery of said core, at least one magnetic circuit having pole pieces so disposed that said magnetic poles move past said pole pieces during the operation of the device, and a winding carried by each of said magnetic circuits, in which said oscillations are generated.

9. Injection device as set forth in claim 8, comprising a stationary magnetic circuit, a movable magnetic circuit driven for rotation about the axis of said core, and means for angularly shifting said movable magnetic circuit relative to said stationary magnetic circuit through an angle varying as a function of the vacuum obtaining in the induction manifold of the engine.

10. Injection device as set forth in claim 9, wherein said means for phase-shifting said oscillations and generating control pulses comprise a first phase-shifting circuit connected to the winding carried by said movable magnetic circuit, said first phase-shifting circuit occasioning phase-displacement of the oscillations generated in said winding as a function notably of the engine speed and of the injection pressure, another phase-shifting circuit connected to the winding carried by said stationary magnetic circuit and adapted to create a phase-displacement in the oscillations generated in said winding, a monostable multivibrator having two input terminals and two output terminals, said two input terminals being connected to the first and second phase-shifting circuits respectively and the corresponding output terminals being connected to said opening and closing circuits of said injectors respectively.

11. Injection device as set forth in claim 10, wherein said pressure compensating means comprise a cavity connected to the delivery side of said high-pressure pump, an inert gas under pressure filling said cavity in contact with the free surface of the fluid, means responsive to the fluid pressure for controlling the phase-displacement of said first and second phase-shifting circuits as a function of said pressure, and means responsive to the fluid temperature for controlling the phase-shifting of said first and second phase-shifting circuits as a function of said temperature.

12. Injection device for spark-ignition engines as set forth in claim 10, comprising an ignition system adapted to be controlled by oscillations and means for feeding oscillations from said first phase-shifting circuits to said ignition system.

13. Injection device as set forth in claim 11, wherein said first phase-shifting circuit comprises an input transformer having a primary winding and a secondary winding, said primary winding being connected to the winding carried by said movable magnetic circuit, said secondary winding having a grounded center tap, a first potentiometer, a thermistor, and another potentiometer connected in series with said secondary winding, said thermistance creating a phase-shift proportional to the engine speed.

14. Injection device as set forth in claim 13, wherein said first potentiometer comprises a slider adapted to short-circuit one portion of its resistor, and wherein means are provided for varying the position of said slider as a function of the density and temperature of the surrounding atmosphere, and consequently creating an additional phase-displacement of said oscillations.

15. Injection device as set forth in claim 13, wherein said other potentiometer of said first phase-shifting circuit comprises a first slider connected to the first input terminal of said monostable multivibrator and wherein means responsive to the pressure and temperature of said fluid are provided for varying the position of said first slider in order to modify the phase-displacement of the oscillations fed to said first input terminal of said monostable multivibrator as a function of the injection pressure and fluid temperature.

16. Injection device for spark ignition engines as set forth in claim 15, comprising an ignition system adapted to be controlled by oscillations and wherein said other potentiometer of said first phase-shifting circuit is provided with another slider connected to the oscillation-controlled ignition system, whereby the ignition controlling oscillations collected by said other slider are phase-shifted in relation to those collected by said first slider.

17. Injection device as set forth in claim 11, wherein said other phase-shifting circuit comprises an input transformer having a primary winding and a secondary winding, said primary winding being connected to the winding carried by said stationary magnetic circuit, said secondary winding having a grounded center tap, a potentiometer in series with said secondary winding, said potentiometer having a slider connected to the other input terminal of said monostable multivibrator.

18. Injection device as set forth in claim 17, wherein means are provided for varying the position of the slider of the potentiometer of said other phase-shifting circuit, said means being controlled by means responsive to the fluid pressure and temperature.

19. Injection device as set forth in claim 8, wherein said oscillation generating means comprise a single stationary magnetic circuit and a winding carried by said stationary magnetic circuit.

20. Injection device as set forth in claim 19, wherein said means for phase-shifting said oscillations and generating control pulses comprise an input transformer having a primary winding and two secondary windings, said primary winding being connected to the winding carried by said stationary magnetic circuit, said two secondary windings having grounded center taps, a first phase-shifting circuit comprising said first secondary winding and creating a phase-displacement of the oscillations generated in the first secondary winding as a function notably of the vacuum obtaining in the induction manifold, of the engine speed and of the injection pressure, another phase-shifting circuit comprising said other secondary winding, a monostable multivibrator having two input terminals and two output terminals, said two input termi-

nals being connected to said first and second phase-shifting circuits respectively whereas said two output terminals are connected to the injector closing and opening circuits respectively.

21. Injection device as set forth in claim 20, wherein said pressure compensating means comprise a cavity connected to the delivery side of said high-pressure pump, an inert gas under pressure filling said cavity and contacting the free fluid surface, means responsive to the fluid pressure to control the phase-shifting action of said first and second phase-shifting circuits as a function of said pressure, and means responsive to the temperature of said fluid to control the phase-displacement of said first and second phase-shifting circuits as a function of said temperature.

22. Injection device for spark-ignition engines as set forth in claim 20, comprising an ignition system adapted to be operated by means of oscillations, and means for applying to said ignition system the oscillations delivered from said first phase-shifting circuit.

23. Injection device as set forth in claim 20, wherein said first phase-shifting circuit comprises a first potentiometer, a thermistor, and another potentiometer connected in series with the first secondary winding, said thermistance bringing about a phase-displacement of said oscillations as a function of the engine speed, and wherein said other phase-shifting circuit comprises a potentiometer connected to the other secondary winding.

24. Injection device as set forth in claim 23, wherein said first potentiometer of said first phase-shifting circuit comprises a slider adapted to short-circuit part of its resistance and wherein means are provided for varying the position of said slider as a function of the vacuum obtaining in the induction manifold and of the air temperature and density, in order to bring about a corresponding phase-displacement of the oscillations.

25. Injection device as set forth in claim 21, wherein said other potentiometer of the first phase-shifting circuit comprises a first slider connected to the first input terminal of said monostable multivibrator and wherein means are provided for varying the position of said slider which are controlled by means responsive to the fluid pressure and temperature so as to vary the phase displacement of the oscillations applied to the first input terminal of said monostable multivibrator as a function of the fluid pressure and temperature.

26. Injection device for spark-ignition engine as set forth in claim 25, wherein said other potentiometer of the first phase-shifting circuit has another slider connected to the oscillation-controlled ignition system whereby the oscillations controlling said ignition system which are collected by said other slider are phase-shifted in relation to those collected by said first slider.

27. Injection device as set forth in claim 23, wherein means are provided for varying the position of the potentiometer slider of the other phase-shifting circuit under the control of means responsive to the fluid pressure and temperature.

No references cited.