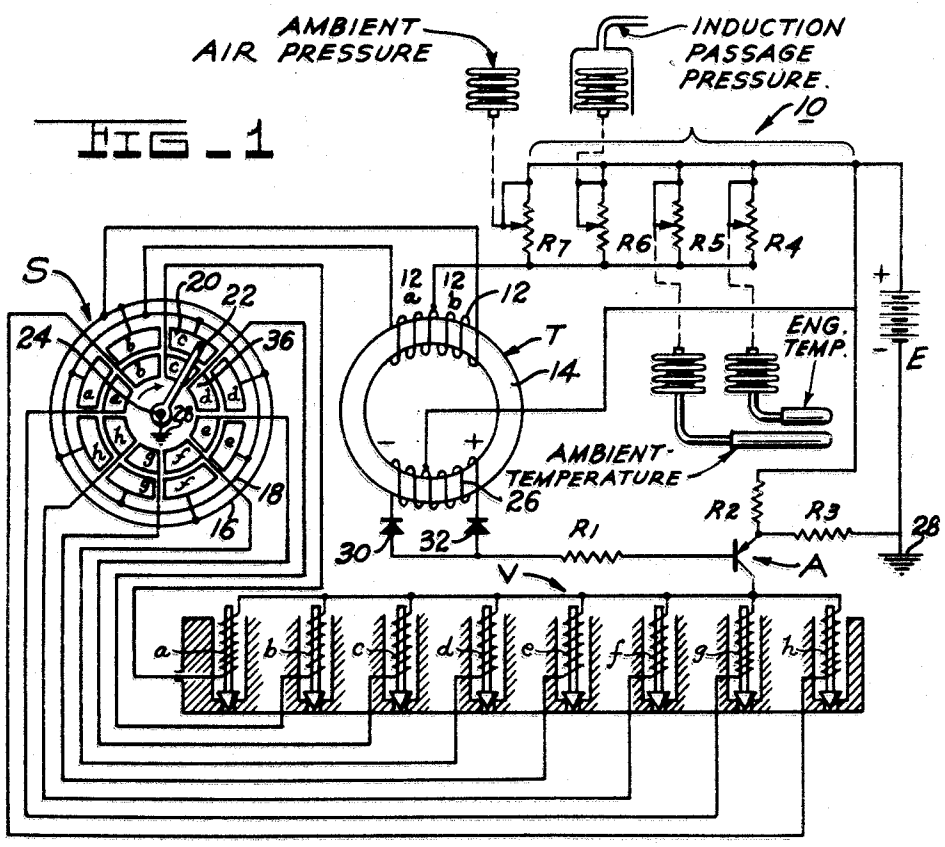
March 8, 1960 D. C. BREEDING 2,927,567

CONTROL FOR A FUEL SUPPLY SYSTEM

Filed Oct. 25, 1956

FIG_1



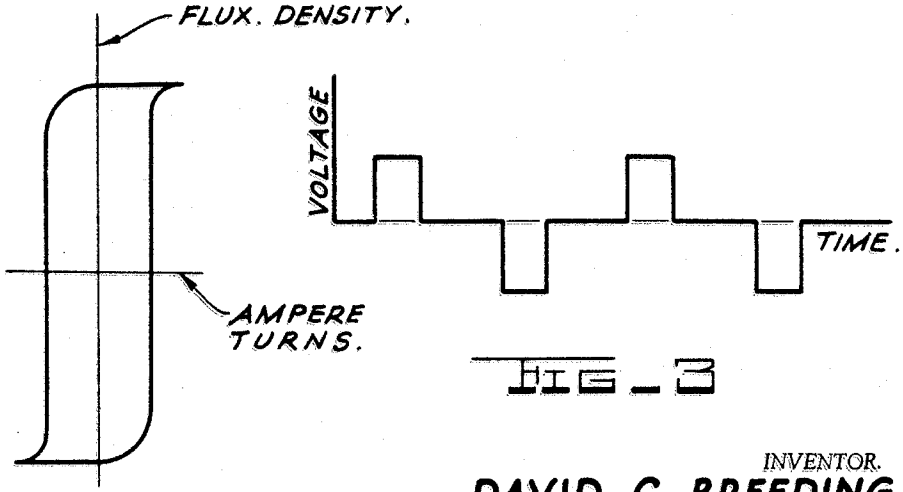


FIG_2

FIG_3

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CONTROL FOR A FUEL SUPPLY SYSTEM

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Application October 25, 1956, Serial No. 618,363

5 Claims. (Cl. 123—119)

The present invention relates to a control for a fuel supply system wherein the quantity of fuel supplied to an engine is controlled by varying the time duration of fuel valve opening. A fuel supply system of this type is disclosed and claimed in U.S. application Serial No. 567,688, filed February 24, 1956, and assigned to the assignee of the present invention and now abandoned.

In an embodiment of the control of my invention a transformer is periodically energized as a function of engine speed to produce for a controlled time duration an output voltage of alternate polarity. The output of the transformer is used to bias an amplifier into conduction for the time duration of transformer voltage output. The amplifier in conjunction with a distributor successively energizes the fuel valves in timed relation to the periodic energization of the transformer.

It is an object of my invention to provide a control for a fuel supply system having simple construction with few moving parts.

It is a further object of my invention to provide a compact, light weight reliable control for a fuel supply system.

Other objects and advantages of my invention will be readily apparent from the following detailed description taken in connection with the appended drawings in which:

Figure 1 is a diagrammatic illustration of a control for the fuel system embodying my invention;

Figure 2 is a characteristic curve of certain operating relations; and

Figure 3 is a characteristic curve of the voltage induced in the secondary of the transformers shown in Figure 1.

Referring now to the drawings there is shown in Figure 1 a source of power E, a transformer T, a switch S, amplifier A and a plurality of electrically actuable valves V. Source of power E is connected through potentiometer **10** to a center tap of primary inductor **12** which is wound on a relatively high retentivity core **14** of transformer T. Potentiometer **10** is variable in response to an engine operating condition such as engine temperature, ambient temperature, relative humidity, ambient pressure, induction passage pressure, exhaust temperature and/or pressure or mass air flow or a combination thereof. The ends of primary inductor **12** are respectively connected to rings **16** and **18** which are alternately connected to successive segmental contacts **20**. A wiper arm **22** mounted on a shaft **24** which is adapted for rotation as a function of engine speed is adapted to successively engage contacts **20** whereby the ends of the primary inductor are alternately connected to ground or reference potential at **28**. The effect of successive engagement of wiper arm **22** with contacts **20** is to cause current to flow in one direction in portion **12***a* of primary inductor **12** and then in the opposite direction in portion **12***b* of primary inductor. Thus when current is flowing in portion **12***a* core **14** is saturated in one direction and when current is flowing in portion **12***b* the core is saturated in an opposite direction. The voltage, time and

flux relationship in transformer T is given by the following equation:

$$Et=2BAN10^{-8}$$

where:

E=voltage
t=time
B=flux density
A=core area
N=number of turns of the inductor

In a given installation B, A and N are constant and may be represented by K.

Therefore:

$$t=\frac{K}{E}$$

Thus by varying the voltage applied to the primary inductor **12** by means of potentiometer **10** the time for the flux in core **14** to change from saturation in one direction to the saturation in the other direction may be controlled. The core **14** is constructed of high retentivity material so as to produce a substantially square loop hysteresis curve as characteristically shown in Figure 2. As to be noted in Figure 2 when the current is reduced to zero as when wiper arm **22** breaks contact with contact **20** there is substantially no change in flux so there is substantially no surge of back E.M.F. in the inductor. A secondary inductor **26** is wound on core **14** so that when the current flows in the primary inductor a voltage will be induced in the secondary while the flux is changing. A characteristic curve of the induced voltage in the secondary for a given applied voltage to the primary is shown in Figure 3. The width or time duration of the induced voltage pulse may be accurately controlled by variation, by suitable means, of the applied voltage to the primary.

In a preferred embodiment amplifier A is a transistor having first, second and third control elements. In the embodiment now described, the emitter or control element is connected to the source E and to ground or a reference potential at **28** through a voltage divider comprising resistances R_2, R_3. The values are selected so that amplifier A is biased in a normally non-conductive state. The emitter is connected through resistor R_2 to a center tap of secondary inductor **26**. The base of amplifier A is connected through current limiting resistor R_1 and a pair of one-way conductive devices or diodes **30** and **32** respectively to the ends of secondary inductor **26**. The collector of amplifier A is connected to each of the solenoids designated **34***a*, *b*, *c*, *d*, *e*, *f*, *g* and *h* in the electrically actuable fuel valve or control members V. The number of valves V may conveniently correspond to the number of combustion chambers in the engine to which the fuel supply system is adapted to supply fuel. It is to be understood, however, that the proportion of valves V to combustion chambers may be increased or decreased as desired. Solenoids **34***a*, *b*, *c*, *d*, *e*, *f*, *g* and *h* are respectively connected to contacts **36***a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* in switch S by an appropriate wiring harness (not shown). Wiper arm **22** is adapted to successively engage contacts **36***a*, *b*, *c*, *d*, *e*, *f*, *g* and *h* in timed relation to the engagement of the arm with contacts **20** whereby the solenoids **34***a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* are successively connected to ground or reference potential at **28**.

In operation a voltage from source E is applied to primary inductor **12** the magnitude of which is varied as a function of engine operating conditions by a potentiometer **10** or other suitable means. Switch S causes the current to flow first in one direction and then in the opposite direction whereby the primary inductor is periodically energized to saturate core **14** of transformer T first in one direction and then in the opposite direction. The time required for the flux of core **14** to change from

saturation in one direction to saturation in the other direction is controllable by varying the magnitude of voltage applied to the primary inductor. The time required for the core to be saturated in one direction from a condition of saturation in the other direction determines the time duration of induced voltage in the secondary inductor 26. A portion of the induced voltage in the secondary is applied to the base of amplifier A and is of sufficient magnitude to cause amplifier A to conduct for the time duration that the induced voltage is applied to the base. When the amplifier A is conductive, current flows from the emitter to the base through resistor R_1 and depending upon the polarity of the induced voltage in secondary inductor 26 through an appropriate one-way conducted device 30 or 32. Because of the pair of one-way conductive devices the amplifier A will conduct irrespective of the polarity of induced voltage in secondary inductor 26. This arrangement permits continuous periodic operation of the control without resort to a resetting device to return the flux in core 14 to a reference value so as to obtain a uniform polarity. When amplifier A is conductive, current flows from the collector to ground successively through solenoids 34*a, b, c, d, e, f, g* and *h* and respective contacts 36*a, b, c, d, e, f, g* and *h* and wiper arm 22.

While only one embodiment of my invention has been described it will be readily apparent to those skilled in the art that various changes and arrangements can be made to attain the objects of the invention without departing from the spirit thereof.

I claim:

1. A control for a fuel supply system, comprising an inductor, means for periodically inducing a voltage in said inductor of alternate polarity, means independent of said first mentioned means for controlling the time duration that said voltage is induced, an amplifier normally biased to a non-conductive stage and means including voltage polarity control means connecting said inductor to said amplifier for biasing said amplifier into conduction during the time duration that said voltage is induced.

2. A control member for a fuel supply system having a plurality of electrically actuable valves, comprising: an inductor, means for periodically inducing a voltage in said inductor of alternate polarity, means independent of said first mentioned means for controlling the time duration that said voltage is induced, an amplifier normally biased to a non-conductive stage, means including voltage polarity control means connecting said inductor to said amplifier for biasing said amplifier into conduction during the time duration that said voltage is induced, a circuit including means actuable in timed relation to said first mentioned means for periodically connecting said amplifier to ground through successive valves.

3. A control for a fuel supply system for an internal combustion engine having an electrically actuable fuel control member comprising a core, primary and secondary inductors wound on said core, variable voltage means responsive to changes in an engine operating condition connected to said primary inductor for saturating said core in alternate directions whereby voltages of alternate polarity are induced in said secondary inductor for a time duration dependent on the voltage applied to said primary inductor winding, an amplifier having first, second and third control elements, means connecting said first element to said secondary inductor intermediate the ends thereof, means including one-way conductive devices connecting the ends of the secondary inductor to the second control element, and means connecting the third element to said member.

4. A control for a fuel supply system for an internal combustion engine comprising a core, a primary inductor mounted on said core, a source of voltage variable in response to changes in an engine operating condition, means connecting said source to said primary inductor intermediate the ends thereof, means synchronized with said engine for alternatively connecting the ends of said primary inductor to ground, a secondary inductor mounted on said core, an amplifier having first, second and third control elements, a pair of conductors connecting the ends of said secondary inductor to the first element of said amplifier, one-way conductive devices in each of said conductors, means connecting said secondary inductor intermediate the ends thereof to the second element of said amplifier, means connecting said source to the second element of said amplifier, a plurality of electrically actuable fuel valves, means connecting the third element of said amplifier to said valves, and means for successively connecting said valves to ground in timed relation to said second mentioned means.

5. A fuel supply system control for an engine having a plurality of electrically actuable fuel valves comprising a core, primary and secondary inductors wound on said core, means synchronized with said engine for periodically causing current to flow in said primary inductor in alternate directions, means responsive to an engine operating condition for varying the intensity of current flow in said primary inductor and thereby the time duration that current is induced in said secondary inductor, an amplifier having first, second and third control elements, means connecting the first element to said secondary inductor intermediate the ends thereof, means including one-way conductive devices connecting the ends of the secondary inductor to the second control element, and means for successively connecting the third element to said valves in timed relation to said first mentioned means.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,927,567 March 8, 1960

David C. Breeding

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 7, for "inductor winding," read -- inductor, --.

Signed and sealed this 18th day of October 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

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