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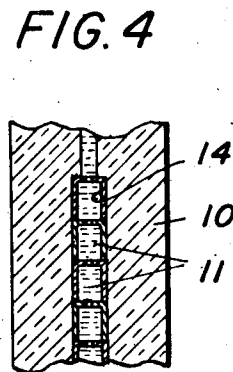
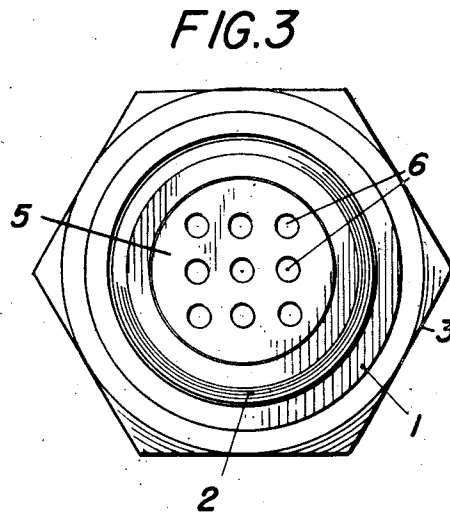
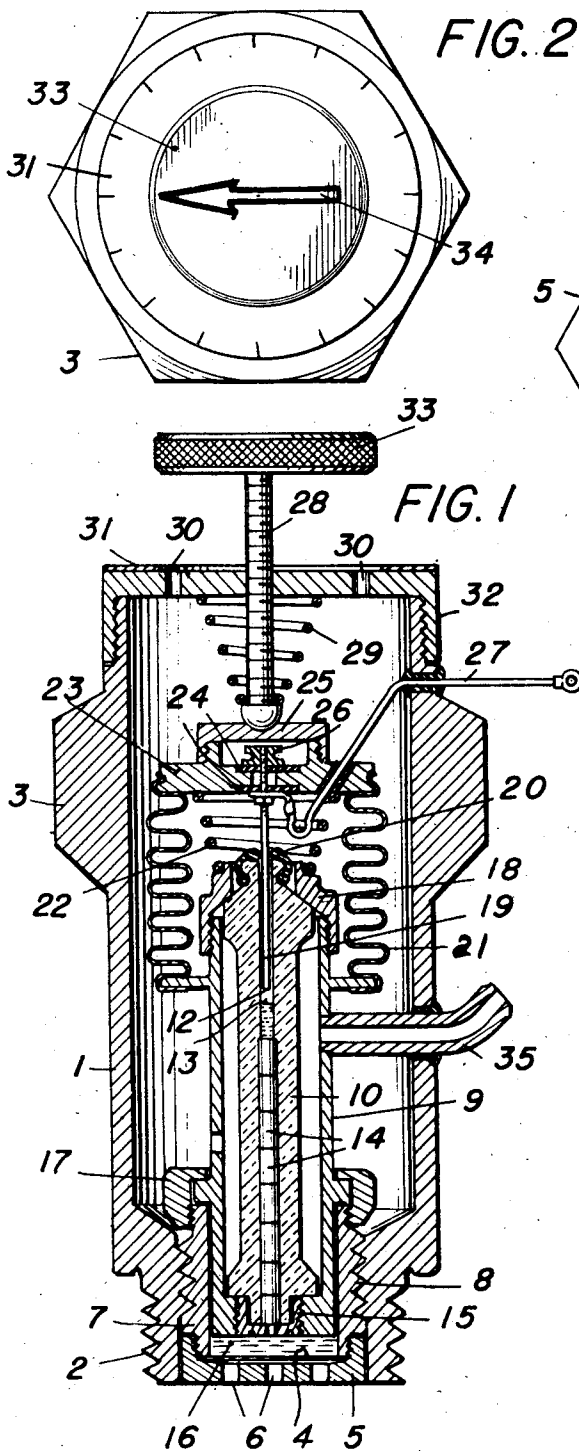
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2,458,086

ENGINE COMBUSTION REGULATING DEVICE

Filed May 9, 1946

2 Sheets-Sheet 1



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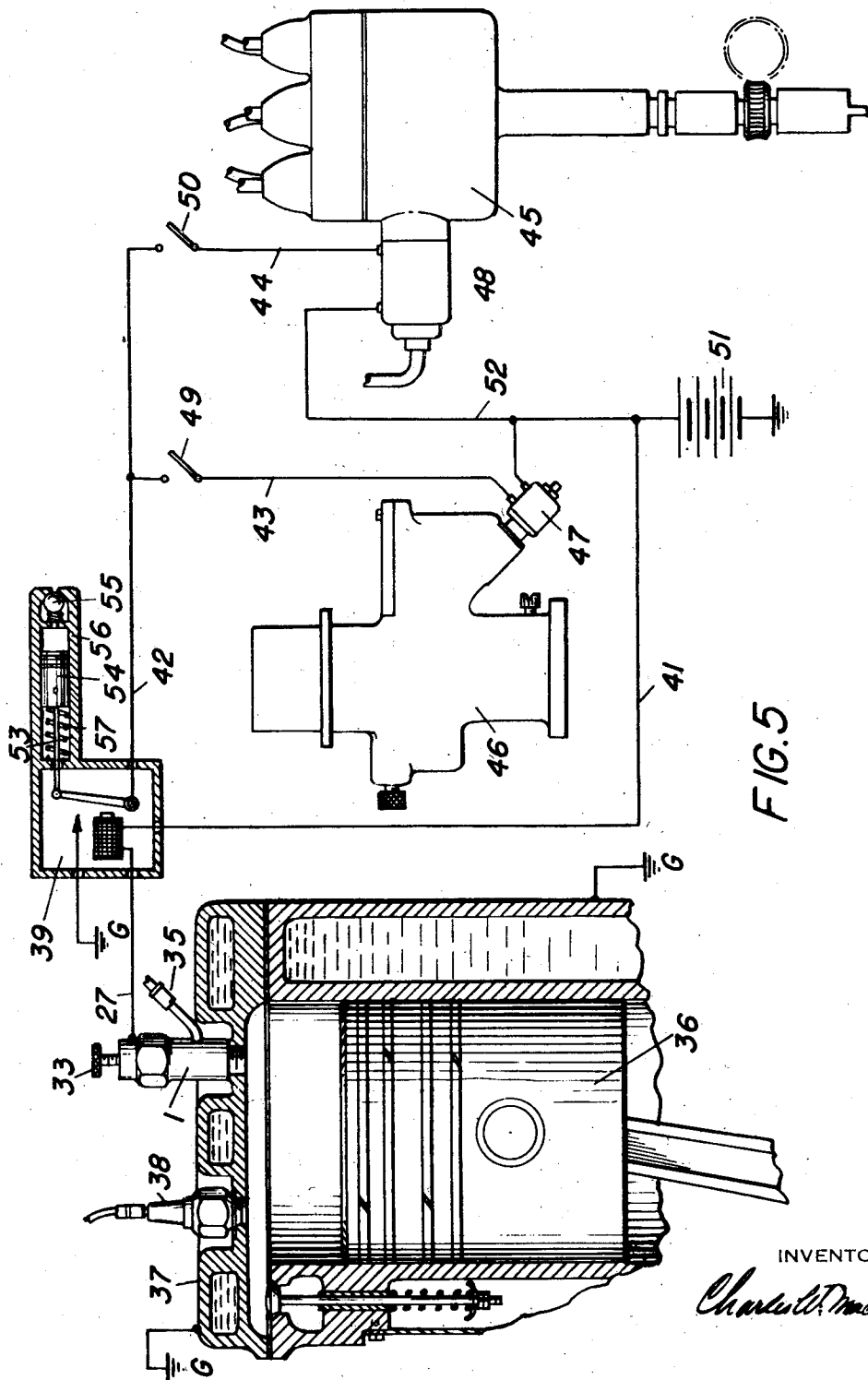
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UNITED STATES PATENT OFFICE

2,458,086

ENGINE COMBUSTION REGULATING DEVICE

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Application May 9, 1946, Serial No. 668,615

5 Claims. (Cl. 123—117)

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This invention relates to engine ignition controlling systems and particularly to engine indicator devices as applied to automatic adjustment of ignition, air-fuel ratio, and fuel injection timing. The use of engine indicators in engineering laboratory work for exploring phenomena occurring in the combustion chambers of engines is well known, and many different types of apparatus have been devised for this purpose. One of the principal difficulties encountered with apparatus of this type has been in the provision of a satisfactory pressure-responsive unit to be inserted in the engine cylinder head and in contact with combustion chamber gases. Many designs of such units have been made to operate satisfactorily for engineering purposes, but under continued operation frequent readjustment, recalibration, or general servicing is required. Furthermore, engine indicators have in general been too expensive and complicated for other than laboratory use.

A primary purpose of this invention is to provide a pressure-responsive unit which may be inserted in an engine cylinder head in contact with combustion gases and which will respond to any predetermined pressure to which the device may be adjusted, the response of the device consisting of closing an electric circuit for operation of engine regulating apparatus.

For descriptions of various associated apparatus reference is made to my Patent No. 2,394,792, dated February 12, 1946, setting forth description of an "Engine ignition controlling device." Reference is also made to my co-pending application, Serial No. 621,309, filed October 9, 1945, for an "Engine fuel controlling device."

Another object is to provide an engine indicator, responsive to combustion chamber gas pressure, the design of which precludes the necessity for frequent readjustment.

Another object is to provide a device for indicating maximum combustion chamber pressure and associated apparatus for automatically producing engine operating adjustment.

Still another object is to provide a device which is responsive to engine combustion chamber gas pressure for the purpose of controlling detonation.

Other objects and singular features will become apparent from the following description.

In the drawings—

Figure 1 is a sectional view of the pressure responsive unit to be inserted in an engine cylinder head;

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Figure 2 is a plan view, and Figure 3 a bottom view of the unit illustrated in Figure 1;

Figure 4 is an enlarged partial view of Figure 1 illustrating a central liquid passage with pulsation dampening means;

Figure 5 is a representative diagram illustrating a combination of parts for a practical application of the device.

A detailed description is as follows: In Figure 1 a housing 1 having a threaded extremity 2 and hexagonal portion 3 is fitted with a cap 32 having air inlet holes 30. A bushing 7 having selected thermal properties is inserted in the end of body 1 and secured therein by means of threads 8. A circular piece 5 with perforations 6 is removably attached to the lower end of bushing 7 and retains a thin diaphragm 4 so as to seal the end of said bushing 7 against leakage. An internal casing 9 contains ceramic or insulated body 10 having a passage 11 and a series of cup-like pieces 14, each of the latter embodying a restricted orifice. The lower end of ceramic body 10 is retained in casing 9 by open plug 15. A liquid, such as mercury, 16 is contained in the space above diaphragm 4 and extends upward through passage 11 to a predetermined position 13. A retaining nut 17 holds the lower end of body 9 in sealed condition within bushing 7. The upper end of casing 9 is fitted with a threaded cap 18 retaining the upper end of ceramic body 10 in alignment. Flexible bellows 21 encloses the upper extremity of casing 9 and body 10. An electrical contact or electrode 19 extends into passage 11 to an adjustable position from a supporting piece 23 from which it is insulated by washers 24 and to which it is secured by nut 26. A closing cap 25 provides a mechanical contact for adjusting screw 28; the latter having knurled head 33 as well as friction spring 29, calibration dial 31 and pointer 34 in its assemblage. An insulated conductor 27 electrically communicates with electrode 19. Spring 22 bears against piece 23 and cap 18 exerting an extending force on bellows 21. A flexible or elastic nipple 20 encloses the upper opening of passage 11 in body 10 while permitting electrode 19 to be slidably adjustable therein. A tube 35 is inserted through housing 1 and casing 9 for cooling purposes.

A representative application of the device is illustrated in Figure 5 in which 36 represents an engine piston. Cylinder head 37 contains a spark plug 38 and pressure-responsive unit the housing of which is denoted by 1. Illustrative of engine regulating sub-devices are carburetor 46 with electromagnetic fuel metering control 47, and

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ignition distributor 45 with electromagnetic spark adjusting control 48, shown connected in circuit with current source 51 and relay 39 by means of conductors 42, 43, 44, and 52. Optional switches 49 and 50 are illustrated as desirable details but may be eliminated without altering the practical operation of the device. Conductor 27 connects the electrode 19 of the pressure-responsive device as shown in Figure 1, with relay 39 which is operatively connected to current source 51 through conductor 41 and ground "G." A small dampening piston 54 operates in cylinder 56 between compression spring 57 and air trapped by check valve 55. Arm 53 connects piston 54 with moving components of relay 39. Tube 35 is normally connected to a vacuum source such as the intake manifold of the engine.

In operation gas pressure resulting from combustion within the engine combustion chamber exerts pulsating forces against flexible diaphragm 4 through openings 6. Each principal pulsation of force so exerted acts coincidentally with the combustion portion of the cycle of piston motion. Since diaphragm 4 is sufficiently thin to elastically respond by a small amount, a few thousandths of an inch or less, to the intermittent combustion pressure, the latter is transmitted in reduced magnitude to the mercury or other suitable liquid 16 which is as a result forced upward, in opposition to the force of gravity, through passage 11 to a height proportional to the intensity of the actuating gas pressure. Pulsation dampening is obtained in passage 11 by means of a series of restricted openings through which the liquid must pass. Thus the transmitted cyclic character of the actuating gas pressure is resisted by fluid friction to the end that an immediate but steady rise or fall of the liquid level 13 in passage 11 takes place in response to, and in proportion to, the intensity of combustion chamber gas pressure. Although other electrically conducting liquids may be suitable, it is contemplated that mercury is the most desirable for this application since it is relatively stable, readily available commercially and possesses a boiling point above the temperature which will be encountered in this application. Electrical contact with electrode 19 is made at the mercury level 13 when the latter rises to the pre-set position 12 of the end of said electrode. Since the mercury body 16 is in contact with metal bushing 7, the electrical circuit is continued through the housing 1 and thence to the engine cylinder head "ground."

Compensation for thermal expansion of liquid body 16 is provided for in the construction of bushing 7 which is preferably made of a material having a coefficient of expansion closely similar to that of the liquid. For example, lead alloy might be used. The lower end of bushing 7 is free to expand downwardly away from its supporting threads 8 thus increasing the volume of the space occupied by liquid 16. Compensation for an increase in this liquid volume due to temperature rise is thereby provided.

It is evident that adjustment of screw 28 to a selected position of pointer 34 relative to dial 31 will adjust the position 12 of the end of electrode 19 to a desired point relative to liquid level 13. Such adjustment would normally be made with the engine operating under a detonating condition so as to produce closing of the electric contact between mercury 16 and electrode 19 as detonation tends to occur. The closing of the mercury-electrode contacts within the pressure-

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responsive unit of Figure 1 causes current to flow from battery 51 through conductors 41, 27, and ground "G," thus actuating relay 39 which closes circuit 42 with ground "G" causing a relatively large current to flow from battery 51 through electromagnetic actuating controls 47 and 48; these controls immediately function to adjust the air-fuel ratio and the ignition timing to preclude detonation within the engine combustion chamber.

In order to prevent erratic operation, it is advisable to incorporate means for producing a short delay with mechanical dampening of the circuit breaking action of the relay 39. This schematic representative means is described as follows. When current flows through conductors 27 and 41 actuating relay 39, piston 54 is moved against spring 57 by the pulling action of arm 53. Suction within cylinder 56 caused by movement of piston 54 unseats ball valve 55 and draws air into the cylinder until piston 54 ceases to move whence ball 55 becomes seated trapping the air drawn in. When current ceases to flow in conductors 27 and 41, relay 39 opens the connection between conductor 42 and ground "G." However, this opening action is resisted temporarily by the trapped air in cylinder 56 which escapes at a designed rate past piston 54. Rapid reversals of the relay from a closed position to an open position are prevented while no restraint or delay is imposed on the closing action of the relay when it is opened.

Obviously, the pressure-responsive device as described and illustrated in Figure 1, may be used for regulating the injection timing of compression-ignition or Diesel engines by suitable electrical controls functioning from relay 39. In such applications, which are definitely contemplated and considered reservable hereunder, the details of spark plug 38, carburetor 46, and distributor 45 would be eliminated, other appropriate linkages being substituted for the two latter parts.

It should also be understood that the device as described and illustrated in Figure 1 may be employed in a variety of ways including laboratory indicating apparatus.

I claim:

1. An electrical contact device comprising a diaphragm and an electrical conducting liquid, means for supporting said diaphragm for exposure of one side to combustion chamber gas pressure of an internal combustion engine, the other side of said diaphragm being in contact with said liquid, said diaphragm being supported to permit flexure under combustion gas pressure, said electrical conducting liquid being disposed to rise thru a plurality of orifices as a result of said flexure of said diaphragm, and an adjustable electrode disposed for contact with said liquid rise, connecting circuits and a battery current source for electromechanical control of selected engine regulating accessories and devices.

2. A pressure responsive electrical contact unit comprising a housing and an internal compartment containing a quantity of mercury, said compartment comprising a flexible diaphragm and thermal volume compensating means, an electrically insulated tube extending vertically from said internal compartment and containing an adjustable electrode, said tube containing a series of restricted orifices disposed for admittance of said mercury, an electric circuit in which said mercury and said electrode form the contacts for closing same with a current source and a relay,

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said relay being connected in circuit for operating electromagnetic engine regulating devices; said electrical contact unit being mounted on an internal combustion engine and said diaphragm being subject to flexure as a result of combustion gas pressure in said engine.

3. A pressure responsive device comprising a housing, a flexible diaphragm, an adjustable contacting electrode, and an electrical conducting fluid, the device disposed in contact with combustion chamber gases of an internal combustion engine, said flexible diaphragm being arranged for flexure as a result of pressure of said combustion chamber gases, and said fluid being disposed to rise as a result of said flexure, an insulated tube extending upwardly from said diaphragm and containing damping means and passage for said fluid rise, a flexible bellows inclosure housing said adjustable contacting electrode, and an electric circuit in which said electrode and said fluid comprise the circuit closing and opening contacts, a relay, and associated circuits for operation of selected engine regulating devices in response to operation of said contacts.

4. An electrical pressure-responsive device adapted for operation with an internal combustion engine and comprising a housing fitted to an engine so as to admit the combustion pressure therein, a flexible diaphragm supported in said housing and exposed to said pressure on one side, a compartment within said housing containing a quantity of mercury, said mercury being in contact with said flexible diaphragm and disposed to rise in an insulated tube, an electrical conductor entering said housing, an adjustable electrode extending downwardly into said tube and connected to said conductor, a series of restricted openings within said tube, and calibrating means to position said electrode in any predetermined position

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with respect to the level of said mercury, and an electric circuit containing a current source, a relay and conductors communicating with said housing and said electrode conductor, the electrode and mercury forming the operating contacts of said circuit for ultimate operation of engine regulating devices connected in circuit with said relay.

5. An electrical pressure responsive device adapted to an internal combustion engine and comprising a flexible diaphragm in contact on one side with combustion chamber gas pressure, a compartment containing mercury and in contact with the opposite side of said diaphragm, an insulated tube extending upwardly from said compartment and containing pulsation dampening means together with openings for the passage of said mercury as same tends to rise, and adjustable electrode insulated from said diaphragm and extending downwardly into said tube, and conductors connecting said electrode and said mercury in circuit with a current source and a relay, said relay being in turn connected in circuit with electromagnetic engine regulating devices.

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The following references are of record in the file of this patent:

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