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B. MILLER

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MOVABLE CORE SPARK PLUG

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Fig. 3.

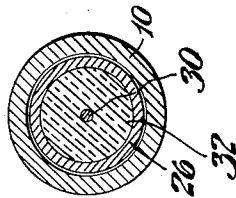


Fig. 1.

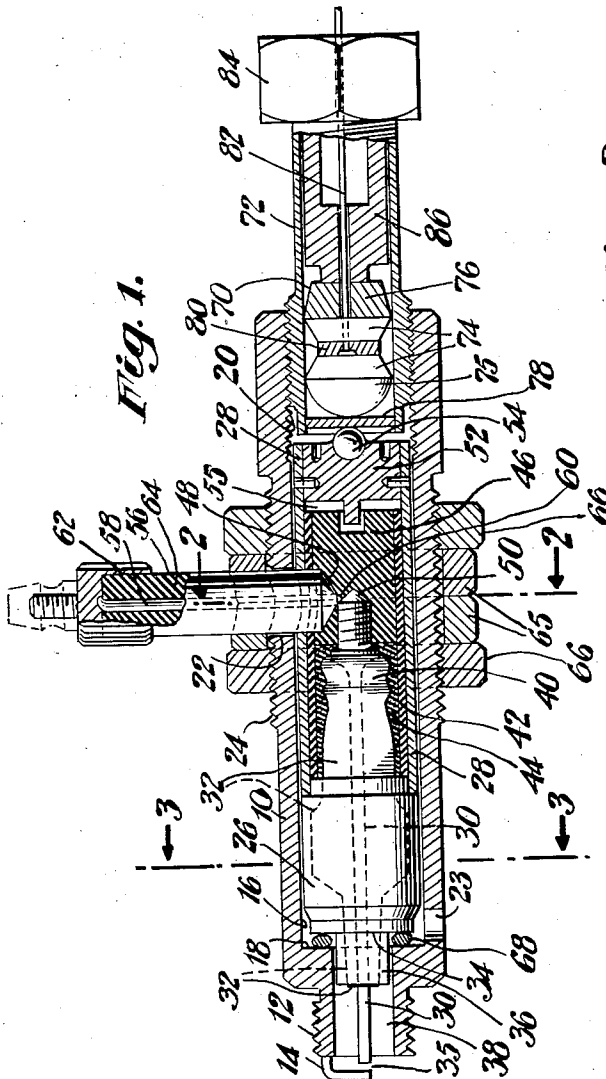
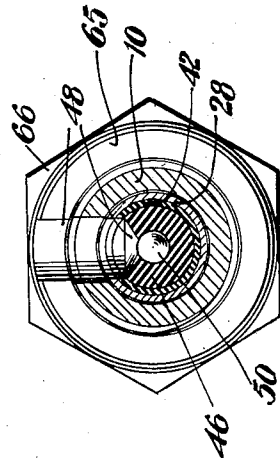


Fig. 2.



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MOVABLE CORE SPARK PLUG

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3 Claims. (Cl. 123—169)

This invention relates to spark plug ignition elements for internal combustion engines, and more particularly to a novel combination of a movable core spark plug and cylinder pressure variation indicator.

In the usual spark ignition internal combustion engine, the head of each cylinder is provided with a single threaded aperture or spark plug hole into which the spark plug element of the ignition system fits. The primary object of the present invention is to provide a novel design of movable core spark plug fitting which can function both as a spark plug and as a pressure variation indicator for studying engine cylinder pressure variations such as occur during the power or combustion phase of a working cycle.

In its broader aspects the invention features a unitary design of spark plug-pressure indicating device in which the center electrode of the spark plug and its dielectric core is moveably mounted within the cylindrical spark plug shell for reciprocation as a piston therein in response to pressure variations in the engine cylinder with which the spark gap is operatively associated, together with elastic pressure indicating means for restraining the movement of the piston, and means for delivering high voltage current for projecting the spark to the center electrode without interfering with free movement of the pressure transmitting piston. More specific objects of the invention are to provide a device so disposed as to allow so far as practicable for the use of standard spark plug cores and parts in the assembly; to provide a design permitting easy replacement of parts and ready threading of the unit into one engine spark-plug aperture where only a limited accessible space is available; and to provide a design which will insure the maintenance of atmospheric pressure within the cylinder in which the piston reciprocates while exposing the working face of the piston to engine cylinder pressures.

With the above and other objects and features in view, the invention consists in the improved spark plug-pressure transmitting and indicator device which is hereinafter described and particularly defined in the accompanying claims.

In the following description of the invention reference will be made to the attached drawing, in which:

Fig. 1 is a longitudinal sectional view of a preferred spark plug-pressure-indicator device in accordance with the present invention, parts being shown in elevation;

Fig. 2 is a cross-sectional view taken on the line 2—2 of Fig. 1; and

Fig. 3 is a cross-sectional view taken on the line 3—3 of Fig. 1.

Referring to Fig. 1, the device therein illustrated embodies a tubular metal cylinder or casing 10 having external threads 12 at the forward end thereof which are adapted to engage the threads of the spark plug hole in an internal combustion engine cylinder head. That end of casing 10 which carries threads 12 also supports an electrode 14 corresponding to the usual grounded electrode of a spark plug. The casing 10 has been shown as preferably having a small cross-section at its electrode end, and a larger cross-section throughout the greater portion of its length. A smooth cylinder bore 16 of uniform cross-sectional area throughout its length lies within the larger cross-sectional end of the casing 10. An annular shoulder 18 is formed on the inner wall of casing 10 at the forward end of cylinder 16 where the central bore of the casing is reduced in size. At the rearward end of the casing and bore 16, the casing is internally threaded at 20 for a purpose which will be later referred to.

At a point intermediate the ends of the casing 10, a circular aperture 22 is provided in the wall of the casing. Also that portion of the casing adjacent aperture 22 is externally threaded by threads 24 extending to both sides of the aperture. A second aperture 23 is provided in the wall of casing 10 at the forward end of bore 16 for the purpose of admitting air to the cylinder bore.

The principal pressure transmitting element of the device is a piston 26 which is movably mounted within bore 16 for reciprocation therein in response to variations in pressure occurring within the engine cylinder within which the electrode end of the device is located when in service. The principal pressure transmitting element of the piston 26 has been illustrated as a tubular cylindrical metal shell 28 mounted coaxially within cylinder 16 and casing 10. Another important element of the piston is a wire electrode 30 which is mounted centrally and coaxially within the shell 28 and extends in length from a point adjacent electrode 14 to a point approximately in line with the center of aperture 22 in casing 10. A great part of the length of the electrode 30 intermediate its ends is encased within a dielectric spark plug shell or core 32 preferably constructed of porcelain or other strong high temperature resistant ceramic material. This dielectric core

32 (which is shown partly in elevation and partly in dotted outline) serves as an insulating wall between electrode 30 and the metal shell 28, all of these parts being built into a unitary piston assembly. A turned-over end of shell 28 which faces the shoulder 18 at the electrode end of cylinder bore 16 is finished with a smooth annular surface 34 forming a working face for the piston 26 which parallels the inner face of shoulder 18.

In the assembled unit, the forward end of electrode 30 is spaced a suitable distance from electrode 14 to provide a spark gap 35. Piston 26 may have a forward tubular extension 36 of shell 28 within which is a cylindrical dielectric extension of core 32 encasing the rearward portion of that part of wire 30 which is centrally mounted in a bore 38 within the small externally threaded electrode end of casing 10. A flexible metal ring gasket 68 is preferably mounted between shoulder 18 and face 34 of the piston for the purpose of preventing leakage of combustion gases from the engine cylinder and space 38 into cylinder 16. A flexible diaphragm connecting the piston and casing 10 might be used in place of gasket 68.

The forward portion of the shell 28 (shown in elevation) and the rearward part of the dielectric core 32 have been illustrated as shaped in a design similar to that of most spark plug elements now on the market. The space lying between the tapered rear portion 40 of the dielectric core and the metal shell 28 has been shown as occupied by a cylindrical dielectric sleeve 42 and by a filling 44 preferably of some dielectric cement such as a heat hardenable phenol-formaldehyde resin. Sleeve 42 extends rearwardly beyond that end of wire 30 which is in line with aperture 22, and a dielectric plug closure 46 is fitted into that end of sleeve 42 in position to surround that portion of the end of wire 30 which is not encased by the shell 32. Apertures are formed in the walls of each of elements 28 and 42 and in plug 46 in line with aperture 22 in the wall of casing 10, such apertures in combination forming a socket 48 having a conical bottom into which projects one beveled side of end 50 of electrode 30 (see Fig. 2).

A metal plug 52 is affixed to the rearward end of piston 26 and shell 28, and a spherical metal ball 54 is preferably fitted into a semispherical socket in that face of plug 52 which forms the rearward end of the piston. An air gap 55 is preferably provided between adjacent sides of the metal plug 52 and dielectric plug 46, in order to protect the plug 46 and other dielectric parts of the piston against any of the compression strains to which the metal parts 28 and 54 are subjected.

To supply the high potential electrical impulses for projecting sparks across gap 35, a conductor plug 56 has been shown as inserted through aperture 22 with its end shaped to fit tightly in socket 48. Electrical impulses for actuating the spark may be delivered to plug 56 from the distributor of the engine by a lead wire which has not been illustrated. Plug 56 comprises essentially a center wire 58, one end 60 of which is beveled to have a tight sliding contact with beveled end 50 of electrode 30 at the base of socket 48, while the other end of wire 58 is affixed to a connector cap 62. The construction of plug 56 is completed by a dielectric shell 64 which encases wire 58 and which has a beveled end shaped to form a tight fit within socket 48. Plug 56 is shown as dimensioned to fit loosely

in aperture 22 of the casing 10, and is provided with means including a pair of clamping rings 65 and a pair of ring nuts 66 threaded to engage the threaded portion 24 of casing 10, whereby plug 56 can be adjustably centered in aperture 22.

This design was developed to permit easy connection and disconnection of the spark gap with the source of energizing current while providing a connection which would not interfere with initial mounting of the spark plug in a difficultly accessible spark plug aperture.

With a construction such as described, a continuous sliding metal-to-metal contact can be maintained between the beveled end 60 of wire 58 in socket 48 and the beveled end 50 of electrode 30, to thereby insure satisfactory functioning of the device as a spark plug, while the piston 26 is reciprocated within the cylinder 16 in a path which may be only a few millionths of an inch in length at a maximum, in response to variations in pressure in the cylinder into which spark gap 35 extends. It will be understood that that end of plug 56 which extends into socket 48 has sufficient lateral flexibility so that it can reciprocate with the piston 26 without serious interference with the piston movement. The internal threads 20 at the rearward end of the casing 10 afford the means for operatively contacting the rearward end of the piston with an elastic means for indicating pressure variations and for restraining movement of the piston.

In order to allow for the use of a cathode ray oscillograph, or similar device, for obtaining visual records of the variations in cylinder pressure which can be accurately transmitted by the device forming the subject of this invention, a preferred elastic pressure indicating and piston-restraining means has been shown in the shape of a piezo-electric generator 70. This generator 70 is operatively connected with the pressure transmitting unit of Fig. 1 in a way such that an electric voltage is generated thereby which varies in proportion to variations in pressure which are developed in the cylinder within which gap 35 is mounted. Voltage generator 70 is mounted in a tubular metal casing 72 having external threads which are adapted to engage the internal threads 20 at the rearward end of casing 10. Generator 70 consists essentially of a pair of quartz crystals 74 which are mounted face to face in casing 72 between a pair of metal electrodes 75-76 which are grounded to the shell 10 of the spark plug. Variations in gas pressure within the cylinder in which gap 35 is located, are transmitted by piston 26 to electrode 75 and through it to crystals 74 through a metal diaphragm closure 78 for that end of casing 72 which contacts ball 54 at the rearward end of the piston. Crystals 74 are mounted in casing 72 in opposed relation with respect to their electrical axes, and their adjacent faces are separated by, and contact, a third insulated electrode 80. By this arrangement of the crystals, when they are subjected to pressure applied along the longitudinal axis of the casing 72 they both develop charges of the same sign at electrode 80, and the potential of the charge varies with variations in the pressure applied to the crystals. A lead wire 82 conducts the electric charge thus developed on electrode 80 to an amplifier (not shown) which may in turn be hooked up with a cathode ray oscillograph.

The rearward end of casing 72 has been shown as threaded for engagement by a threaded cap 75

34 for the casing. A plunger 88 is mounted inside casing 72 and attached to cap 84 for movement therewith to apply an initial compression to crystals 74. By advancing casing 72 along threads 20, plate 78 is forced into tight pressure contact with the ball 54 on piston 26. By this arrangement gasket 68 may be subjected to a pressure sufficient to seal prior to instituting operation of the spark plug-indicating device.

10 Having thus described the invention, what is claimed as new is:

1. A combined spark plug-pressure indicating unit comprising an externally threaded tubular metal casing having an electrode mounted at the forward end thereof, a smooth wall cylinder bore within the casing, a piston mounted for reciprocation within the cylinder bore in response to variations in pressure in a chamber with which the forward end of the casing communicates in service, said piston comprising an axially disposed wire electrode and a dielectric core embedding the wire electrode, a spark gap formed between the casing electrode and the forward end of the wire electrode, means for supplying current for actuating the spark gap including an aperture in the wall of the casing intermediate its ends, a socket in the piston aligned with said casing aperture and with the rearward end of the coaxial wire electrode, and an insulated lead-in wire conductor having an end adapted for insertion into said socket through said aperture

with an uninsulated terminal in sliding contact with the rearward end of said electrode, and elastic means for restraining the movement of the piston.

2. Apparatus as defined in claim 1 together with means for clamping the lead-in wire conductor in center position within said lateral casing aperture and piston socket, the end of said lead-in wire being shaped to form a loose fit in said aperture and a tight fit within said socket.

3. A combined spark plug-pressure indicating unit comprising, an externally threaded tubular metal casing having an electrode mounted at the forward end thereof, a smooth wall cylinder bore within the casing, a piston mounted for reciprocation within the cylinder bore in response to variations in pressure in a chamber with which the forward end of the casing communicates in service, said piston comprising an axially disposed wire electrode and a dielectric core embedding the wire electrode, a spark gap formed between the casing electrode and the forward end of the wire electrode, means for supplying current for energizing the spark gap without interference with the movement of the piston, a metal closure for the rearward end of said piston having a spherical ball contact element mounted on the rearward face thereof and elastic means for restraining the movement of the piston.

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