

Aug. 20, 1968

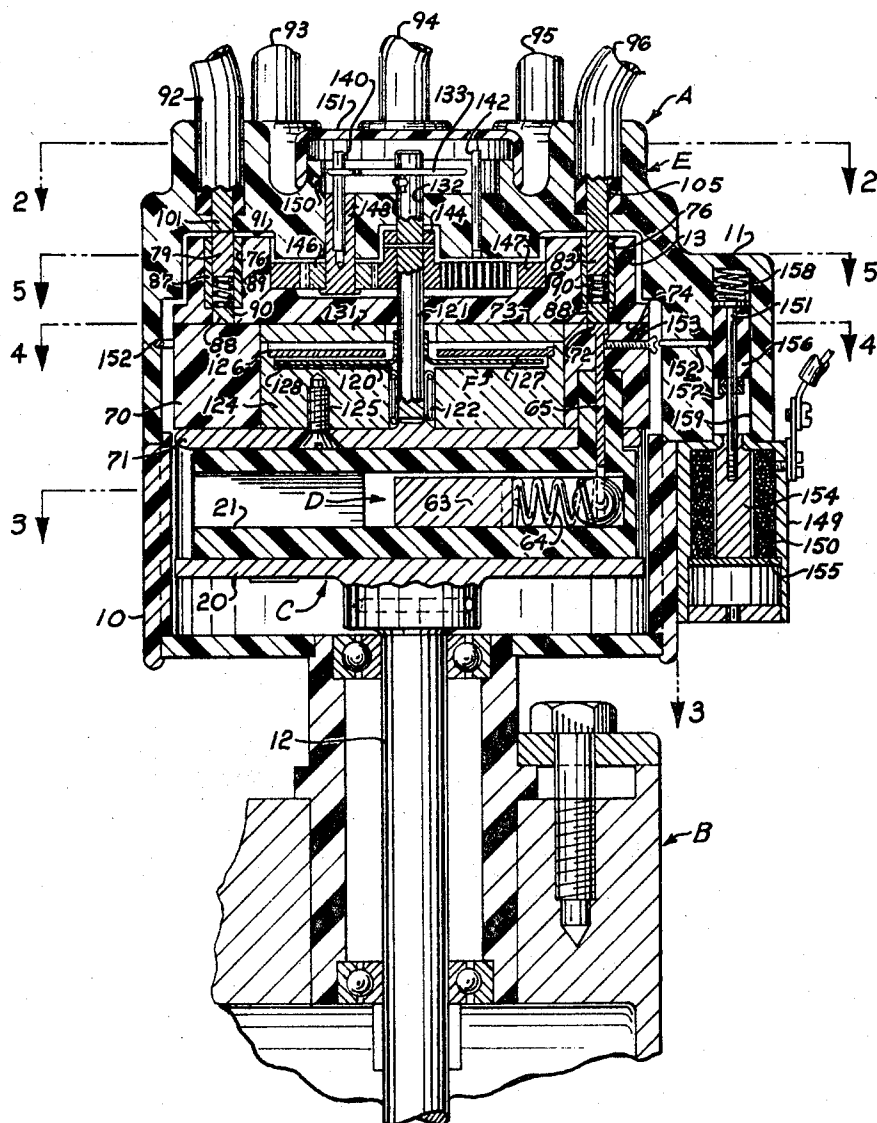
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3,397,683

IGNITION APPARATUS

Filed Feb. 25, 1966

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

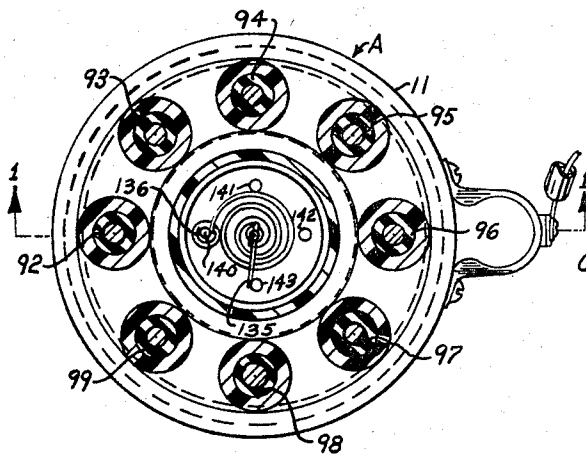


FIG. 2

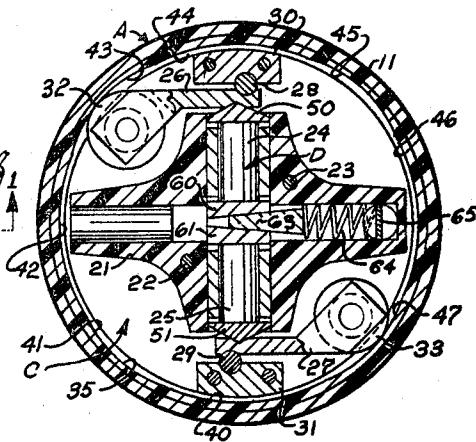


FIG.3

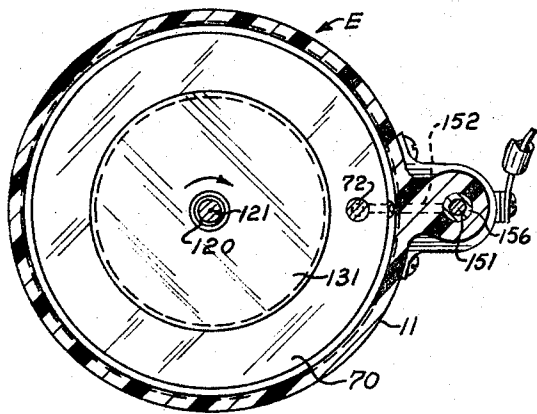


FIG.4

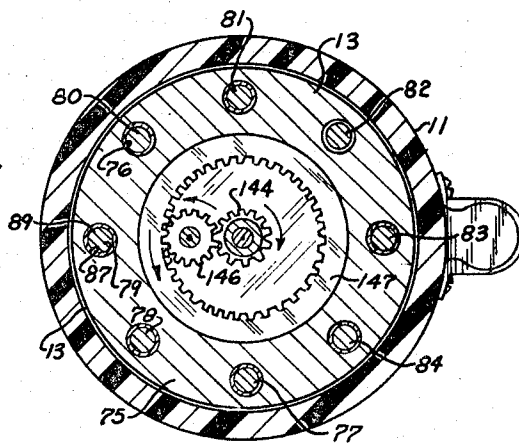


FIG.5

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Filed Feb. 25, 1966

3 Sheets-Sheet 3

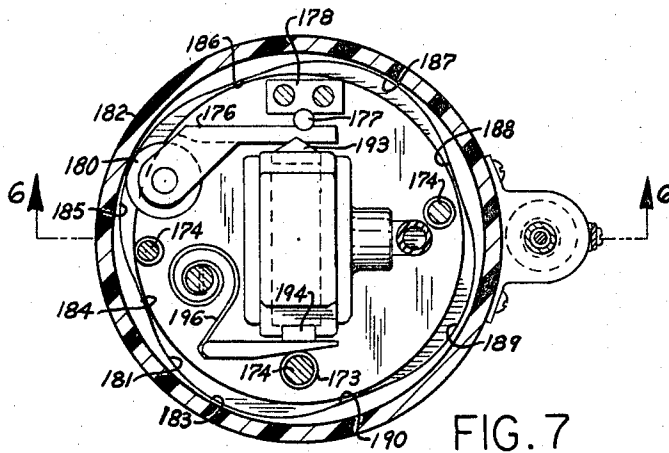


FIG. 7

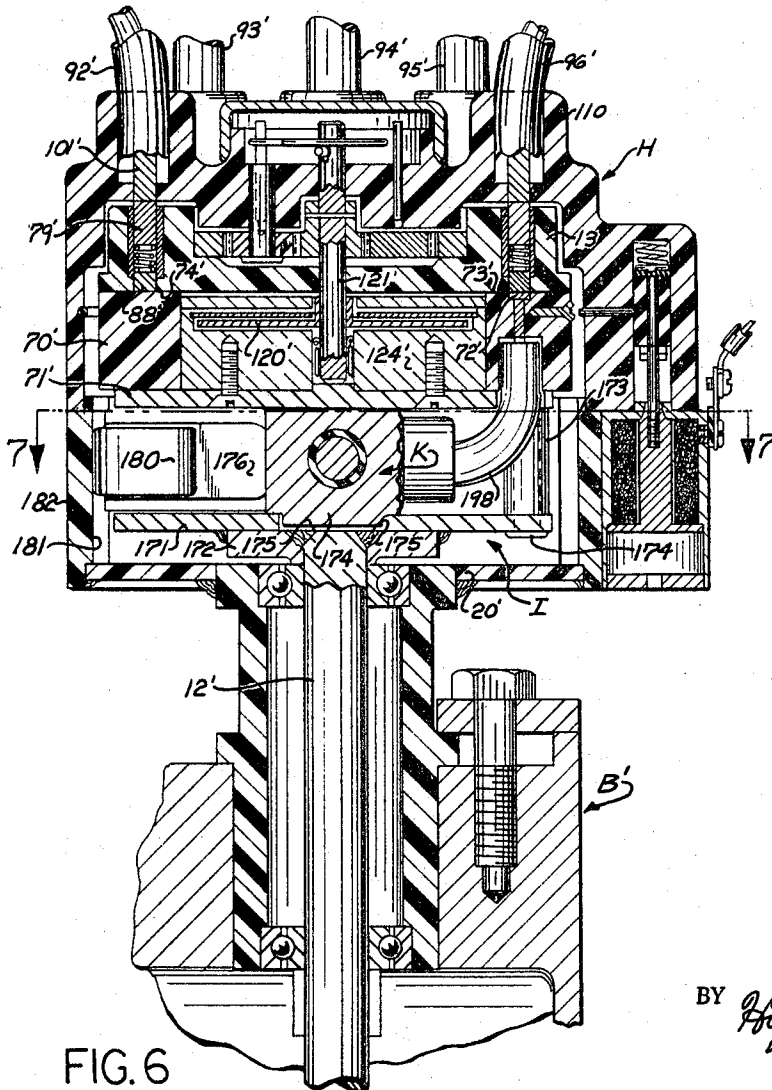


FIG. 6

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3,397,683
IGNITION APPARATUS
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 Filed Feb. 25, 1966, Ser. No. 530,183
 8 Claims. (Cl. 123—148)

ABSTRACT OF THE DISCLOSURE

An ignition system for an internal combustion engine including a distributor having at least one contact flush with a smooth annular internal surface thereof adapted to be electrically connected with a spark plug of the engine, a rotatable generator assembly having a smooth surface in sliding engagement with the annular surface of the distributor and provided with a flush contact which momentarily engages the contact carried by the distributor upon rotation of the generator assembly, piezoelectric elements carried by the generator assembly and electrically connected to the contact of the generator assembly, and means for periodically and simultaneously squeezing and relaxing the piezoelectric elements in timed relation to rotation of the engine.

The present invention relates to ignition systems for internal combustion engines the air-fuel mixture of which is ignited by an electric spark and more particularly to ignition systems for internal combustion engines of the character referred to, preferably of the multi-cylinder type, which ignition systems include piezoelectric means for developing the electrical potential used to produce the spark which ignites the air-fuel mixture in the cylinder or cylinders of the engine.

One of the principal objects of the invention is the provision of a new and improved ignition system for internal combustion engines, preferably of the multi-cylinder types, which utilize an electric spark to ignite an air-fuel mixture in the cylinder or cylinders of the engine, which system includes a piezoelectric element for providing the electrical potential required to produce the desired spark or sparks, means for causing the piezoelectric element to produce the required potential, and means for conducting the potential to the spark plug or plugs of the engine at the desired time and with a minimum loss of potential.

Another object of the invention is the provision of a new and improved ignition system for internal combustion engines, preferably of the multi-cylinder type, which utilize an electric spark for igniting an air-fuel mixture in the cylinder or cylinders of the engine, which system includes a piezoelectric element for providing the electrical potential required to produce the desired spark or sparks, means for causing the piezoelectric element to produce the required potential in advance of the time it is to be utilized, and means for subsequently conducting the potential to the spark plug or plugs of the engine at the desired time.

Another object of the invention is the provision of a new and improved ignition system for internal combustion engines, preferably of the multi-cylinder type, which utilize an electric spark for igniting an air-fuel mixture in the cylinder or cylinders, which system includes a piezoelectric element for providing the electrical potential required to produce the desired spark or sparks, means for causing the piezoelectric element to produce the required potential in advance of the time it is to be utilized, and means for subsequently conducting the potential to the spark plug or plugs of the engine at the desired time, which last-mentioned means includes means for establish-

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ing direct contact between relatively movable conducting members and preventing the conduction of the potential to the spark plug or plugs of the engine until the direct contact between the relatively movable conducting members is made.

Another object of the invention is the provision of a new and improved ignition system for internal combustion engines, preferably of the multi-cylinder type, which utilize an electric spark for igniting an air-fuel mixture in the cylinder or cylinders of the engine, which system includes a piezoelectric element for providing the electrical potential required to produce the desired spark or sparks in combination with means for causing the piezoelectric element to produce the required potential in advance of the time it is to be utilized, means for subsequently conducting the potential to the spark plug or plugs of the engine including relatively movable conducting members adapted to make a direct engagement with one another to conduct the potential to the spark plug or plugs of the engine, and means for varying the time of establishing the direct engagement between the relatively movable conducting members as a function of the rotational speed of the engine.

Another object of the invention is the provision of a new and improved ignition system for internal combustion engines, preferably of the multi-cylinder type, which utilize an electric spark for igniting an air-fuel mixture in the cylinder or cylinders of the engine, which system includes a piezoelectric element carried by a member adapted to be rotated in timed relation to the rotation of the engine for providing the electrical potential required to produce the desired spark or sparks, means for causing the piezoelectric element to produce the required potential in advance of the time it is to be utilized, means for subsequently conducting the potential to the spark plug or plugs of the engine including conducting members movable relative to one another adapted to make direct engagement with one another to conduct the potential to the spark plug or plugs of the engine, and fluid coupling means between the conducting members for varying the time of establishing the direct engagement between the relatively movable conducting members as a function of the rotational speed of the engine.

Another object of the invention is the provision of a new and improved ignition system for internal combustion engines of the character referred to, which system includes a piezoelectric element carried by a member adapted to be rotated in timed relation to the rotation of the engine, means movable against at least one end of the piezoelectric element for alternately compressing and relaxing the element causing the element to produce the required electrical potential, and means for conducting the potential to the spark plug or plugs of the engine.

Another object of the invention is the provision of a new and improved ignition system for internal combustion engines of the character referred to, which system includes a piezoelectric element carried by a member adapted to be rotated in timed relation to the rotation of the engine within a housing having an interior cam surface or track thereon, lever means operable against at least one end of the piezoelectric element, roller means carried by the lever means and engageable with the cam surfaces or track on the housing for alternately compressing and relaxing the element to cause the element to produce the required electrical potential, and means for conducting the potential to the spark plug or plugs of the engine.

Further objects and advantages of the invention will be apparent to those skilled in the art to which it relates from the following detailed description of two preferred embodiments thereof made with reference to the accom-

panying drawings forming a part of the specification and in which:

FIG. 1 is a sectional view, approximately at the line 1—1 of FIG. 2, of a portion of an ignition system embodying the present invention;

FIG. 2 is a sectional view taken approximately at line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken approximately at line 3—3 of FIG. 1;

FIG. 4 is a sectional view taken approximately at line 4—4 of FIG. 1;

FIG. 5 is a sectional view taken approximately at line 5—5 of FIG. 1;

FIG. 6 is a sectional view taken approximately at line 6—6 of FIG. 5, of a portion of a second ignition system embodying the present invention; and

FIG. 7 is a sectional view taken approximately at line 7—7 of FIG. 6.

The present invention relates to an improved ignition system for an internal combustion engine, preferably of the multi-cylinder type, having a spark plug or plugs for igniting the fuel mixture in the cylinder or cylinders of the engine. The ignition system, generally speaking, includes a spark generating means including a piezoelectric unit, and distribution means for connecting the piezoelectric unit to the spark plug or plugs of the engine to ignite a fuel-air mixture in the combustion chamber or chambers thereof at the proper time in the cycle of operation of the engine.

In the preferred embodiments of the invention shown, the piezoelectric unit is a part of an assembly rotatable within a stationary housing and is alternatively compressed and relaxed upon rotation of the assembly to produce the desired electrical potential by at least one lever rotatable within the housing with the piezoelectric means and provided with a roller which traverses a cam track on the interior of the housing having radially high and radially low portions. The potential is produced in advance of the time in the cycle of operation of the engine when it is to be used and is directly conducted to the spark plug or plugs at the proper time without the intervention of an air gap and with minimum loss of potential. Provision is also made automatically advancing or retarding the time when the potential is delivered to the spark plug or plugs as a function of the rotational speed of the engine crankshaft. As shown, this is accomplished by a distribution member operatively connected to the rotatable assembly which carries the piezoelectric unit by means including a fluid coupling which permits the distribution member to move angularly relative to the rotatable assembly carrying the piezoelectric unit as a function of the speed of the engine.

Referring to the drawing, the ignition system shown in FIGS. 1 to 5 of the drawings comprises a two-part housing member, designated generally by the reference character A, adapted to be fixedly secured to a stationary part of the engine with which the system is used, for example, the engine block B. The lower part 10 of the housing A is shown as formed of various metal and/or plastic members welded or otherwise connected to one another, although it could be molded as a single plastic part. The upper or cover part 11 of the housing A is preferably a plastic molded member.

The housing A contains a first or potential generating assembly C which includes a piezoelectric element or unit D for producing the electrical potential and which assembly is fixed to the upper end of a shaft 12 rotated in timed relation to the rotation of the crank shaft of the engine to alternately compress and relax the piezoelectric element to produce the required electric potential. The upper part 11 of the housing A and a member 13 positioned therebetween the top of the generator assembly C forms a second or distributor assembly E for distributing the electric potential to the spark plugs of the engine. The member 13 is oscillatable relative to the upper

part or cover 11 of the housing A to advance or retard the spark as will be hereafter described.

The input or driving shaft 12 is journaled in the lower portion or part 10 of the housing A and carries at its upper end the generator assembly C comprising a flanged base member 20 pinned to the shaft 12 and which member 20 in turn carries a member 21 fixed to its upper side by screws 22 and 23 and which member houses two spaced, axially aligned piezoelectric elements 24 and 25.

The piezoelectric elements are adapted to be alternately squeezed or compressed in the direction toward one another and released or relaxed by a pair of levers 26 and 27. The levers 26 and 27 are fulcrumed adjacent to one of their ends about cylindrical members 28 and 29, respectively, which are supported by abutment members 30 and 31 carried by the base member 20. Opposite ends of the levers 26 and 27 carry rollers 32 and 33 which travel about a cam track or surface 35 on the interior of the lower member 10 of the stationary housing A. The cam track has alternately radially high and low portions 40 to 47. The crests of the radially high portions 40, 42, 44 and 46 and the valleys of the low portions 41, 43, 45 and 47 are arcuate in shape and are of considerable length. As shown each crest of the high portions and the bottoms of each valley extend through an arc of about 40°.

As the first or generating assembly C rotates, the levers 26 and 27 simultaneously compress the piezoelectric elements 24 and 25 through members 50 and 51 interposed between the ends of the piezoelectric units 24 and 25 and the levers 26 and 27, respectively, as the rollers 32 and 33 ascend and travel along oppositely disposed high portions of the cam track 35. The levers 26, 27 allow the piezoelectric elements to relax as the rollers enter and travel along oppositely disposed radially low portions of the cam track. Since there are four crests and four valleys in the cam track 35 the piezoelectric units are compressed and allowed to relax four times for each rotation of the generator assembly C thus producing eight potentials or potential periods.

The ends of the piezoelectric units 24 and 25 adjacent to one another abut or engage movable members 60 and 61 within the member 21. The sides of the members 60 and 61 facing one another are inclined to produce a V-like space therebetween and a wedge member 63 is interposed therebetween. The wedge member 63 is biased by a spring 64 in a direction to force it between the members 60 and 61 to automatically take up any slack or looseness in the mechanism. The spring 64 is interposed between the member 63 and a contact member 65 having a spherical lower end contacted by the spring 64. The piezoelectric elements 24 and 25, the members 50, 51, 60, 61, 63 and 64, and the lower end of the contact member 65 are located in suitable apertures in the member 21.

The contact member 65 is molded into the member 21 and extends upwardly through a boss 66 on the upper side of the member 21 which boss extends into an aperture opening into the underside of a ring-like member 70. The members 21 and 70 are made of plastic insulating material. The boss 66 projects through an aperture in a plate 71 interposed between the member 21 and the member 70. The boss 66 fits in the apertures in the members 70 and 71 without looseness or play thus causing the members to rotate with the member 21 as a part of the first or generator assembly C.

The upper end of the member 65 is enlarged and forms a short arcuate contact member 72 which terminates in the plane of a smooth annular upper surface 73 of the member 70. The surface 73 engages a smooth annular lower surface 74 of the member 13 of the distributor assembly E and rotates relative thereto.

The member 13 of the distributor assembly E, which is made of plastic insulating material, includes an up-

wardly projecting ring-like boss 75 and has a plurality of annularly spaced-apart openings 76 therein within which contact assemblies 77 to 84 are positioned. Each of the contact assemblies 77 to 84 includes a sleeve member 87 located in the upper counterbored ends of the apertures 76 and a pair of spaced contact members 88 and 89. The contact members 88 and 89 of each assembly are slidably disposed in their respective sleeve members 87 and the lower ends of the apertures 76 and are biased oppositely, that is, in a direction away from one another by a spring 90 interposed therebetween. The contact members 88 are biased downwardly by the springs 90 and into contact with the upwardly facing surface 73 of the member 70 and the upper surface of the contact member 72 which surface is flush with the surface 73. The contact members 89 are urged or biased by the spring 90 in an upwardly direction and into engagement with a downwardly facing annular surface 91 in the interior of the cover member 11 of the distributor assembly E.

The contact member 72 in the first or generator assembly C sequentially and momentarily engages the contact members 88 in the member 13 of the distributor assembly E as the generating assembly C is rotated. The potential developed by the generator assembly is transmitted from the contact member 72 to a contact member 88 in the distributor assembly only during engagement of the contact member 72 with the member 88 because the surfaces 73 and 74 closely engage one another and without any air gap therebetween and because the plastic material of the members 70 and 13 are of such dielectric strength that arcing between the contact 72 and the contacts 88 is prevented as the contact 72 approaches individual ones of the contact members 88. Since the surfaces 73, 74 are in engagement with each other there is no air gap between approaching contacts and arcing between approaching contacts which would result in preignition is prevented. The potential delivered to the contacts 88 is transmitted to the contacts 89 through the spring 90 and sleeve 87.

The one end of the conductors 92 to 99 extending between the distributor assembly E and the spark plugs of the engine terminate in or are connected to arcuately-shaped contact members 101 to 109, respectively, equally spaced about and having the lower surfaces flush with the annular surface 91 within the cover member 11 of the housing A. The contact members 89 are urged by the spring 90 into engagement with the surface 91 and the undersides of the contact members 101 to 108 with the result the electric potential is conducted from a contact member 89 directly to the particular spark plug with which it is associated.

The member 13 which carries the contact assemblies 79 is oscillatable relative to the potential generator assembly C and the cover 11 of the housing A by the action of a fluid coupling F so that the contact assemblies 79 may be moved angularly relative to the potential generator assembly to automatically vary the spark timing as a function of the speed of the engine. The fluid coupling F comprises a disk or plate-like member 120 carried by a shaft 121 the lower end of which rests upon the member 71 of the potential generator assembly and is rotatably supported by needle bearing 122 in a member 124 secured to the top of the plate 71 of the potential generator assembly C by a plurality of screws 124, only one of which is shown in the drawings. The member 124 includes a central cylindrical aperture therein for receiving an end of the output shaft 121 and the needle bearings 122 which rotatably support the shaft. The member 124 includes a peripheral, stepped, upstanding flange 126 at an upper side within the upper end of which is fixed an apertured plate 127 forming a viscous shear fluid chamber 128 in the member 124. The wheel-like plate 120 fixed to the shaft 122 is positioned in a viscous shear fluid contained in the chamber 128. The upper and lower sur-

faces of the fluid coupling member 120 lie closely adjacent upper and lower walls of the chamber 128. An annular plate-like member 131 is supported on the flange 126 and is spaced from the member 127 to form a chamber therebetween which is effective to prevent loss of the fluid from the generator assembly C. An upper surface of the member 131 is co-extensive with the planar surface 73 of the member 70. The output shaft 120 extends through apertures in members 127, 131, 13 and through an opening 132 in the cover 11.

The output shaft 121 of the fluid coupling is rotatable relative to the cover 11 in response to viscous shear forces acting on the coupling member 120. Rotation of the output shaft 121 relative to the housing 11 in a clockwise direction as viewed in FIG. 2 is resisted by a spiral spring 133 surrounding the upper end of the output shaft 120 and having its inner end bent downwardly to engage a pin 135 extending radially from the upper end of the output shaft 121. The opposite or outer end 136 of the spring 133 is adapted to engage with one of a plurality of pins 140-143 equally spaced from one another on the cover member 11 and extending upwardly therefrom. The spring 133 biases the output shaft 121 in a counterclockwise direction and rotation of the output shaft 121 due to the bias of spring 133 is limited by engagement of the pin 135 with the pin member 143.

At a predetermined speed of rotation of the generator assembly C, torque transmitted through the fluid coupling F is sufficient to overcome the bias of the spring 133 and the output shaft 121 is rotated against the bias of the spring in a clockwise direction.

Rotation of the output shaft 121 rotates a gear 144 secured as by a pin to the output shaft 120 in a clockwise direction which in turn rotates a gear 146 meshed therewith in a counterclockwise direction. The gear 146 is rotatably supported by a headed shaft-like member 148 which is mounted in the cover 11 and which supports the pin 140. The gear 146 meshes with a ring gear 147 fixedly secured to the member 13. Counterclockwise rotation of the gear 146 causes counterclockwise rotation of the ring gear 147 which results in rotation of the member 13 in a counterclockwise direction. Rotation of the member 13 in a counterclockwise direction moves the contact members 88 relative to the housing A and the generator assembly, to a position where they are contacted by the contact 72 earlier in the cycle of the engine to advance the spark.

The amount of spark advance may be adjusted by adjusting the tension in the spring 133. The end 136 of the spring 133 may be engaged with any of the pin members 140 through 143 to effect this adjustment. The cover 11 of the housing A includes an upstanding flange 150 which surrounds the output shaft 121 and pin members 140 through 143. The flange 150 supports a cap member 151 which snugly engages the flange 150 to protect the spark advance mechanism and which is removable to permit access to the spring 133 for adjustment purposes. This adjustment of the spark advance is particularly useful in matching the spark timing to octane rating of a particular fuel used in the engine.

The end portions of the conductors 92 to 99, as previously mentioned, are enlarged and form circumferentially extending arcuate contact surfaces for the transmission of an electric potential between the contact members 89 and each of the conductors. This configuration of the ends of the conductors 92 and 99 permit the member 13 to be rotated relative to the housing to advance the spark while maintaining electrical contact between the contacts 89 and their respective conductors.

In order that the engine may be stopped when desired, means is provided for diverting the spark from the spark plug to ground, and thereby preventing ignition. As shown in the drawings, the means for preventing ignition includes a housing 149 secured to the lower portion 10 of the housing A and surrounds a solenoid coil 150. The solenoid coil 150 is operable on actuation of a switch, not

shown, to move a headed shorting pin 151 into and out of engagement with an annular shorting ring 152 surrounding the potential generating assembly C. The shorting ring 152 is positioned on an inner periphery of the cover 11 of the housing A and closely adjacent a shorting conductor 153 connected to the conductor 65 in the generator assembly C. It will be apparent that as the generator assembly C rotates, the shorting conductor 153 rotates therewith in close proximity to the shorting ring 152. The lower end of the shorting pin 151 is connected to an armature member 154 reciprocable in the solenoid coil 150 upon energization of the solenoid. The armature 154 includes an enlarged flange portion 155 which limits movement of the armature in both directions by engagement with portions of the housing 149. The upper end of the pin 151 carries an annular body of insulating material 156 fixed between an abutment 157 on the pin and the head thereof. When the ignition switch is turned on and the solenoid is actuated the armature 154 and the parts connected thereto including the shorting pin 151 are moved upwardly against the bias of a compression spring 158 interposed between the head of the pin 151 and the bottom of a recess or aperture 159 in the cover 11 and within which the upper end of the pin 151 is slidably supported to the position shown in the drawings. With the parts in this position the insulating material 156 prevents conduction between the shorting ring 152 and ground. When the ignition switch is turned off the solenoid 150 is de-energized and the armature 154 moves down under the force of gravity and the spring 158 to a point where the flange 155 engages the bottom portion of the housing 149. At this position, the head of the shorting pin 151 contacts the portion of the shorting ring 152 extending to the aperture 159. When the shorting pin 151 and the shorting ring 152 contact, the potential developed in the generator assembly C is conducted through the shorting conductor 148 and arcs to the shorting ring 152. The potential is conducted from the shorting ring 152 through the shorting pin 151, armature 154 and housing 149 to ground.

FIGS. 6 and 7 disclose a modified ignition system embodying the present invention and wherein parts, which are duplicates of those shown in FIGS. 1 to 5, are designated by the same character references, but with prime marks attached thereto. The only changes in the ignition system shown in FIGS. 6 and 7 over the system shown in FIGS. 1 to 5 are in the potential generating assembly and the contour of the cam surfaces within the bottom part of the housing and only those parts will be described in detail.

In the modified embodiment the potential assembly I includes a base plate 171 positioned above and welded to a smaller plate 172 rigidly connected to the upper end of the input or drive shaft 12' connected for rotation with the crank shaft of the motor as previously discussed. In the embodiment being described, the plate 71' is connected to and spaced from the plate 171 by a tubular sleeve 173 surrounding rivets 174 extending through the plates 71' and 171. The piezoelectric unit K is fixedly secured between the plates 71' and 171 and has a downwardly extending portion 174 which fits within an aperture 175 in the plate 171.

The piezoelectric element is adapted to be alternately compressed and relaxed by a lever 176 which is also carried by the base plate 171. The lever 176 is fulcrumed adjacent one of its ends about a cylindrical member 177 carried by the base plate 171 and supported by an abutment member 178. The opposite end of the lever 176 carries a roller 180 which travels about a cam track 181 forming an inner peripheral surface of a lower portion or member 182 of the stationary housing H. The cam track 181 includes radially high and low portions 183-190 along which the roller 180 is moved as the generator assembly I rotates. The radially high and low portions 183-191 are arcuate in shape and are of considerable length. The crests

and valleys of the radially high and low portions form dwell portions on the cam track 181 which extend through an arc of about 40 degrees.

As the generator assembly I rotates the lever 176 is rotated slightly about the pivot pin 177 as a result of engagement between the roller 180 and the cam track 181, to compress and relax the piezoelectric element K. The lever 176 acts on the piezoelectric element K through a member 193 interposed between the end of the piezoelectric element and a portion of the lever 176 intermediate the roller 180 and pivot pin 177. The piezoelectric element is compressed as the roller ascends and travels along the crest of the radially high portions 184, 186, 188, 190, and is allowed to relax as the roller travels along the radially low portions 183, 185, 187, 189 of the cam track 182. Since there are four crests and four low portions on the cam track 182 the piezoelectric element will be compressed and relaxed four times during one revolution of the generator assembly I to produce eight potentials or potential periods.

The end of the piezoelectric element K opposite the end engaged by the member 193, engages a block 194 which is supported against movement by a wedge member 195 interposed therebetween and one of the spacer sleeves 173. The wedge member 195 is associated with a spiral spring 196 supported on the base plate 171 and which urges the wedge member 195 between the fixed abutment 173 and the block 194. The wedge member 195 compensates for shrinkage, etc. of the piezoelectric unit.

As the generator assembly I rotates, the potential developed by the piezoelectric element K is conducted from the unit through a conductor member 198 to a contact member 199 terminating in the annular rotatable upper surface 73' of the member 70 of the generator assembly I. As the generator assembly rotates in the housing H, the potential developed in the piezoelectric element is delivered from the contact member 199 sequentially to the contacts 88' in the distributor assembly E' from which the potential will be conducted to individual ones of the spark plugs of the engine.

The operation of the ignition device illustrated in FIGS. 6 and 7 is substantially the same as that illustrated in FIGS. 1-5 and will not be described as its operation can be understood from a consideration of the description of the operation of the ignition system shown in FIGS. 1-5.

From the foregoing description of the preferred embodiments of the invention, it will be apparent that the objects hereinbefore enumerated and others have been accomplished and that there has been provided a novel and proved ignition system for an internal combustion engine. Because of the sliding contact feature of the present invention which eliminates air gaps and the use of a piezoelectric element to produce the required high potential as described, at no time are there any high voltage circuits or conducting ionized conducting paths interrupted or broken. The voltage or potential generated in the piezoelectric element is discharged through the spark plug or plugs of the engine and dissipated before the circuit is broken. The absence of an air gap in the sliding contact area prevents any premature ionization and arcing prior to the meeting of the contacts thus providing sharp accurate timing of the high voltage discharge.

While the preferred embodiments of the present invention have been described in considerable detail the invention is not to be considered limited to the precise construction shown. My intention is to hereby cover all adaptations, modifications and uses of the ignition shown which come within the practice of those skilled in the art to which the invention relates and within the scope of the appended claims.

What I claim is:

1. An ignition system for an internal combustion engine including a housing, a distributor assembly contained in said housing and having at least one contact adapted to be electrically connected with a spark plug of the engine,

said distributor assembly having a smooth annular internal surface and said contact being substantially flush therewith, a generator assembly rotatably supported in said housing and having a smooth surface in sliding engagement with said annular surface of said distributor assembly, said generator assembly having a contact which is substantially flush with said smooth surface thereon and which momentarily engages the contact carried by said distributor assembly upon rotation of said generator assembly, means adapted to operatively connect said generator assembly with said engine for rotation of said generator assembly in timed relation to rotation of the engine, first and second piezoelectric elements carried by one of said assemblies and electrically connected to the contact of said generator assembly, and cooperable means carried by said generator assembly and said housing for periodically and simultaneously squeezing and relaxing said piezoelectric elements in timed relation to rotation of the engine to cause the piezoelectric elements to periodically generate electric potentials.

2. The ignition system defined by claim 1 wherein said piezoelectric elements are aligned on said generator assembly, and said cooperable means include first and second lever members operatively associated with ends of said piezoelectric elements and which are operable in response to rotation of said generator assembly to move simultaneously in opposite directions toward and away from said piezoelectric elements to squeeze and relax said piezoelectric elements in timed relation to rotation of the engine.

3. The ignition system defined by claim 2 wherein said piezoelectric elements are separated by means for supporting said piezoelectric elements and resisting movement of said elements in response to movement of said lever means, said support means including a wedge member movable in response to a change in dimension in said piezoelectric elements to compensate for shrinkage of said piezoelectric elements.

4. The ignition system defined by claim 1 wherein said cooperable means includes first and second lever members mounted on said generator assembly for rotation therewith and a cam track forming an inner periphery of said housing and wherein said cam track and said first and second lever members are cooperable to cause rotation of said lever members relative to said generator assembly upon rotation of said generator assembly, each of said lever means being pivotally supported on said generator assembly and including a portion intermediate ends thereof for applying a compressive force to an associated piezoelectric element in response to rotation of said lever member in one direction and for relaxing said piezoelectric element in response to rotation of said lever member in an opposite direction.

5. An ignition system for an internal combustion engine including a housing, a distributor assembly rotat-

ably supported in said housing and including at least one contact adapted to be electrically connected with a spark plug of the engine, said generator assembly having a contact which is substantially flush with the smooth surface thereon and which sequentially engages the contact carried by said distributor assembly upon rotation of said generator assembly, piezoelectric means carried by one of said assemblies and electrically connected to the contact of said rotatable generator assembly, means for compressing and relaxing said piezoelectric elements in timed relation to rotation of the engine to cause said piezoelectric element to periodically generate electric potentials, and spark advance means operatively associated with said generator assembly and said distributor assembly for moving said distributor assembly relative to said generator assembly and said housing in response to rotational speed of said generator assembly, said spark advance means comprising a fluid coupling including a chamber formed in said generator assembly, a viscous shear fluid in said chamber and an output coupling member in said chamber having a surface adjacent to a wall of said chamber and being operatively connected with said distributor assembly.

6. An ignition system of the type defined by claim 5 including means biasing said output coupling member against movement at rotational speeds of said generator assembly below a predetermined speed, and wherein said output coupling member overcomes said biasing means and moves against said biasing means at rotational speeds of said generator assembly above said predetermined speed to move said distributor assembly relative to said generator assembly and said housing.

7. An ignition system of the type defined by claim 6 wherein said output coupling member includes a shaft member and wherein the shaft member is operatively associated with a gear unit operable on rotation of the shaft in one direction to rotate said distributor assembly relative to generator assembly and said housing in an opposite direction.

8. An ignition system of the type defined by claim 7 and further including stop means on said housing and operable to limit movement of said output coupling member in response to action of said biasing means in one direction, and to limit movement of said output coupling member in an opposite direction in response to torque transmitted through said fluid coupling.

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