Sept. 27, 1960 J. R. HARKNESS 2,954,506

MEANS FOR TIMING PLUG FIRING IN PIEZOELECTRIC IGNITION SYSTEM

Filed June 15, 1959 3 Sheets-Sheet 1

Fig. 1.

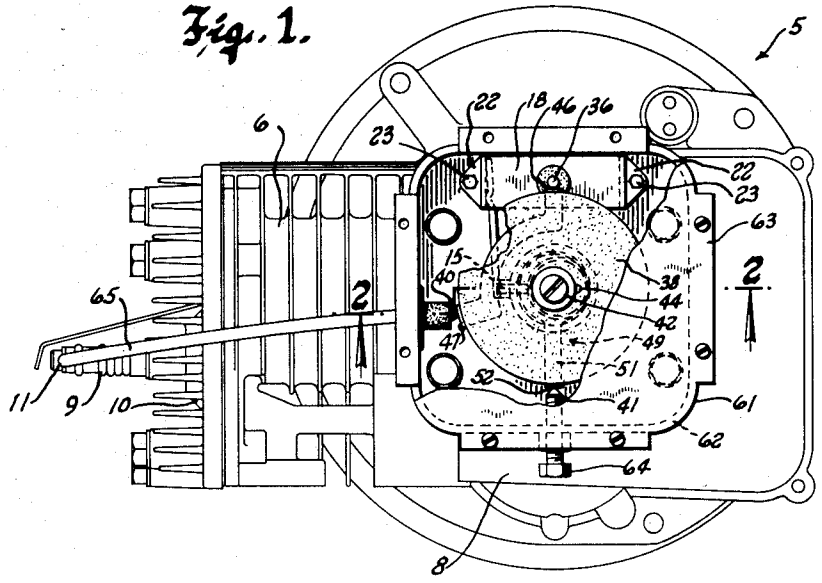
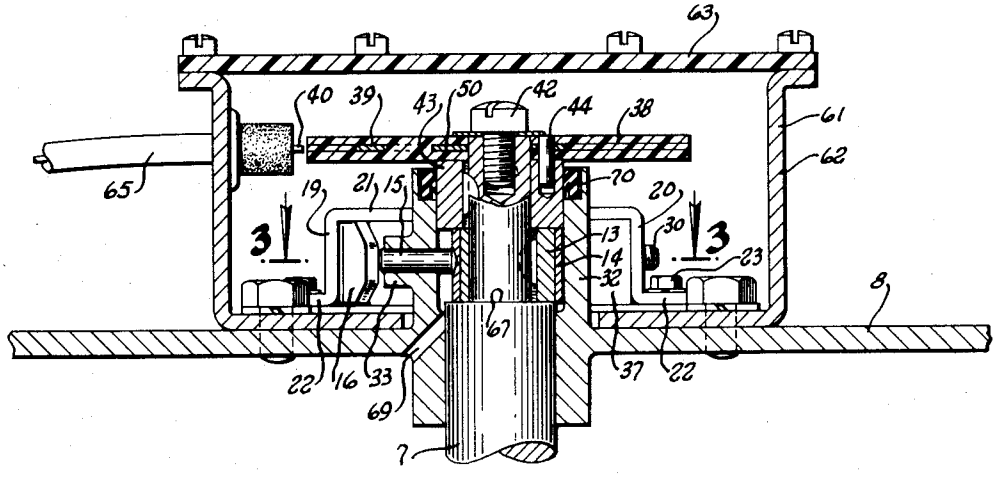


Fig. 2.



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MEANS FOR TIMING PLUG FIRING IN PIEZOELECTRIC IGNITION SYSTEM

Filed June 15, 1959 3 Sheets-Sheet 2

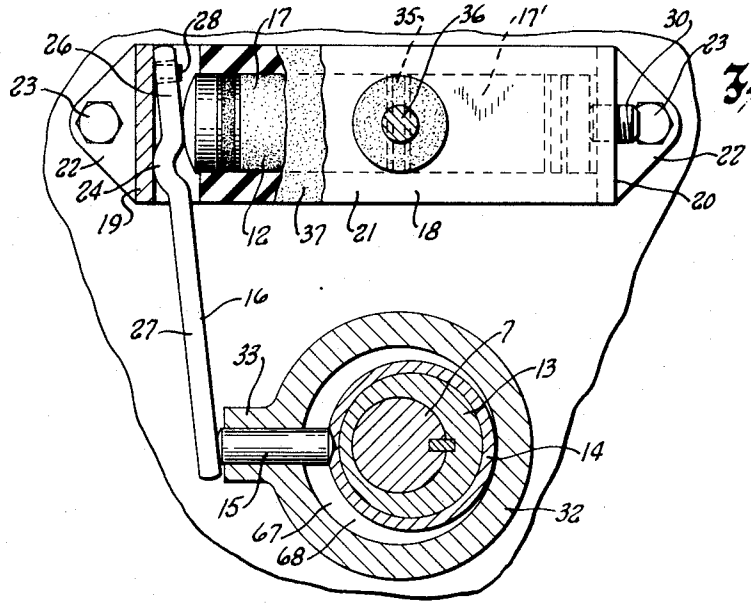


Fig. 3.

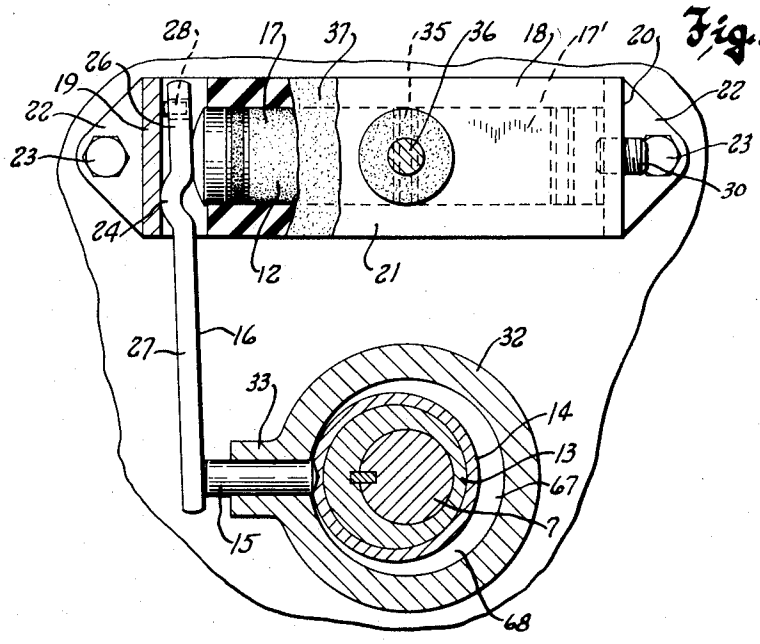


Fig. 4.

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MEANS FOR TIMING PLUG FIRING IN PIEZOELECTRIC IGNITION SYSTEM

Filed June 15, 1959 3 Sheets-Sheet 3

Fig. 7.

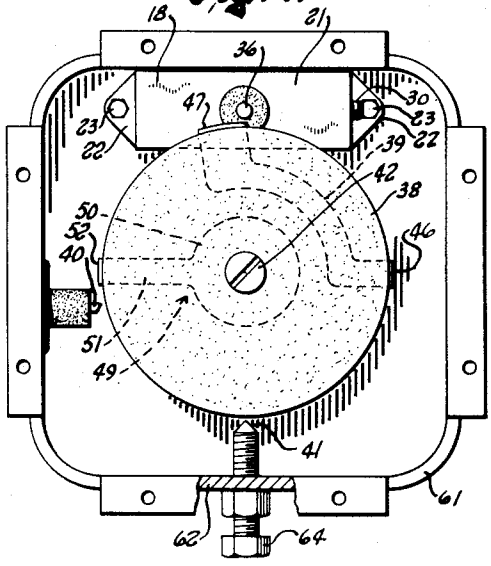


Fig. 6.

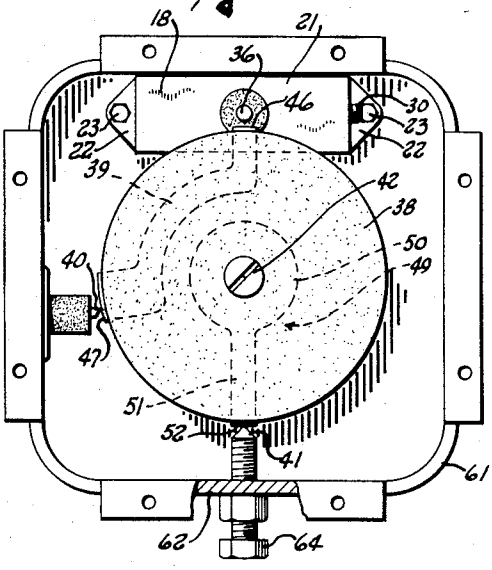


Fig. 8.

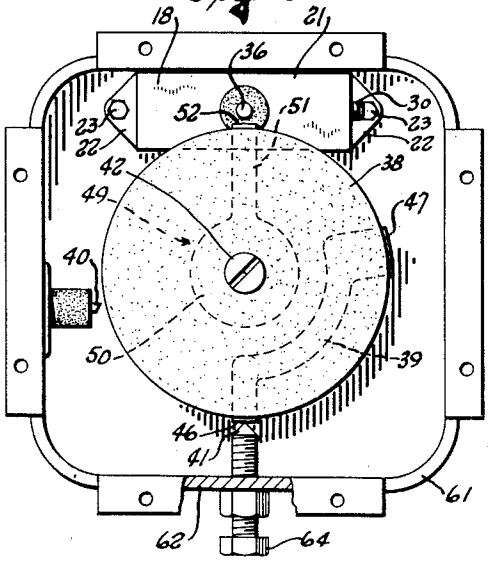
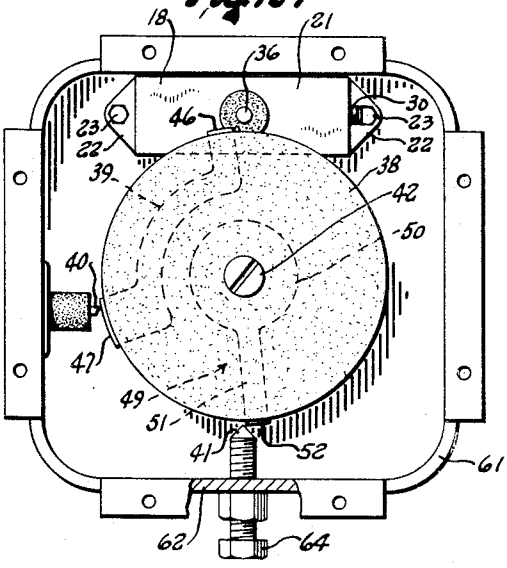


Fig. 5.



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Patented Sept. 27, 1960

2,954,506

MEANS FOR TIMING PLUG FIRING IN PIEZOELECTRIC IGNITION SYSTEM

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Filed June 15, 1959, Ser. No. 820,472

12 Claims. (Cl. 315—55)

This invention relates generally to piezoelectric ignition systems for reciprocating internal combustion engines, wherein high tension voltage for firing a spark plug is derived from alternate compression and relaxation of a polycrystalline piezoelectric element in timed relation to rotation of the engine crankshaft. More specifically this invention relates to distributors for such ignition systems, by which the high tension E.M.F. developed across the terminals of the piezoelectric element is applied to a spark plug at the proper time to effect firing of the plug.

In an ignition system of the character here under consideration, a polycrystalline piezoelectric element of barium titanate or the like, usually referred to as a crystal, is compressed under steadily increasing force during one portion of the engine cycle and is relaxed during another part of the cycle, such alternate squeezing and relaxation of the crystal being effected by means of an eccentric driven by the engine crankshaft and connected with the crystal through a lever or other motion transmitting member. Peak voltages appear across the terminals of the crystal at the maximum values of its compression and relaxation, and a distributor having a crankshaft driven rotor electrically connects the spark plug with the crystal at a predetermined instant near one of the voltage peaks to effect firing of the plug.

One form of distributor for timing the electrical connection of the spark plug with the crystal element has an axial arrangement of the distributor elements. An output stationary electrode, connected with the spark plug "hot" terminal, is axially in line with an input stationary electrode connected with the "hot" terminal of the crystal, and an orbitally movable axially extending conductor or shunt on the distributor rotor moves into circuit making relationship with the two stationary electrodes at the proper instant for spark plug firing.

While satisfactory for some purposes, this axial distributor arrangement could not be used successfully where there was a possibility of end play in the shaft that carried the distributor rotor, since the spacing of the air gaps between the fixed electrodes and the orbitally movable shunt is critical, and rubbing of the parts could occur if even a relatively small end play developed. It appears to be more practical, therefore, to employ a radial distributor arrangement wherein a circumferentially extended distributor shunt is carried for orbital movement and the stationary electrodes connected with the spark plug and the crystal element are circumferentially spaced from one another and located closely adjacent to the shunt orbit. However, the radial arrangement also poses problems due to pecularities common to all piezoelectric ignition systems of the type described above.

A piezoelectric element has some tendency to retain a charge across its terminals, although a certain amount of leakage takes place through the element. Since the peak voltage due to compression of the element is of opposite sign to the peak voltage due to its subsequent relaxation, the retained voltage of each sign tends to

cancel the next peak voltage of opposite sign unless the crystal is discharged at about the time that each peak voltage appears. One of the peak voltages during each cycle is not used in a single cylinder engine, and some provision must be made for grounding it off.

Partly because of the leakage which takes place across the crystal, the potential across the crystal, even under optimum conditions, is relatively low for spark ignition purposes. Consequently assurance must be had that no leakage from the crystal to ground occurs during the period when a used peak voltage is building up, and particularly during the interval immediately preceding firing of the plug. Under some circumstances such leakage can take place through the conductive member of the rotating distributor element unless the same is very well insulated from ground.

With the foregoing considerations in mind, it is the general object of this invention to provide distributor means for a piezoelectric igniter system of the character decsribed wherein axial play of the distributor rotor shaft does not affect operation of the system, wherein grounding of an unused peak voltage is readily provided for, and wherein undesired leakage to ground of the charge across the piezoelectric element is avoided without the necessity for very heavy insulation of the conductive shunt on the distributor rotor.

A more specific object of this invention is to provide a distributor for a piezoelectric igniter system wherein a circumferentially extended orbitally movable shunt or bridging conductor first moves into circuit making relationship with an output stationary electrode connected with a spark plug and then, while maintaining such relationship with the output electrode, moves into circuit making relationship with an input stationary electrode connected with the piezoelectric element, so that the bridging conductor is in circuit making relationship with the spark plug before the piezoelectric element is effectively connected in the spark plug circuit, thus avoiding undesired leakage of current to ground through the bridging conductor, even though it is not very heavily insulated.

Another specific object of this invention is to provide a distributor for a piezoelectric igniter system which has the characteristics described in the preceding statement of object and which incorporates simple and effective means for grounding unused peak voltages across the piezoelectric element and for preventing firing of the spark plug at undesired times during the engine cycle.

It is also an object of this invention to provide apparatus for applying one of the high tension voltage peaks appearing across an alternately compressed and relaxed piezoelectric element to a spark plug at the proper time for firing the plug, which apparatus prevents leakage to ground of the useful voltage across the piezoelectric element and avoids sparking of the plug at undesired times, but provides for ready grounding of the piezoelectric element to discharge the unused peak voltage therefrom.

Another object of this invention resides in the provision of a distributor for applying one of the peak voltages appearing across an alternately compressed and relaxed piezoelectric element to the firing of a spark plug, in which distributor the size and dielectric value of the distributor rotor insulation are not critical.

With the above and other objects in view which will appear as the description proceeds, this invention resides in a novel means substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention con-

structed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a plan view of a vertical shaft single cylinder gasoline engine having a piezoelectric ignition system embodying the means of this invention;

Figure 2 is a vertical sectional view on an enlarged scale taken on the plane of the line 2—2 in Figure 1;

Figure 3 is a horizontal sectional view taken on the plane of the line 3—3 in Figure 2, showing the mechanism in the position in which the piezoelectric element is at maximum relaxation;

Figure 4 is a view similar to Figure 3 but showing the mechanism in its position in which the piezoelectric element is under maximum compression;

Figure 5 is a fragmentary plan view of the distributor, showing the rotor in the rotational position it occupies immediately prior to the firing of the spark plug;

Figure 6 is a view similar to Figure 5, but showing the rotor in its position at the time the spark plug is fired;

Figure 7 is also a view similar to Figure 5, but showing the rotor shortly after firing of the plug; and

Figure 8 is a view similar to Figure 5, showing the rotor in the rotational position in which its grounds off the unused peak voltage from the piezoelectric element.

Referring now to the accompanying drawings, in which like numerals designate like parts throughout the several views, the numeral 5 designates generally a vertical shaft gasoline engine having a cylinder 6 in which a piston (not shown) reciprocates to drive a crankshaft 7 that is rotatably journaled in a crankcase 8. The engine shown is of the single-cylinder four-cycle type, but it will be understood that the invention is also applicable to multi-cylinder engines, and to two-cycle as well as four-cycle engines.

As is conventional, the fuel-air mixture drawn into the cylinder during each cycle is ignited at the proper moment by means of a spark plug 9, grounded to the engine by its connection to the cylinder head 10 and having a high tension or "hot" terminal 11. The high voltage required for firing the plug is produced by the alternate compression and relaxation of a polycrystalline piezoelectric element 12, sometimes referred to as a crystal. The mechanism by which such alternate stressing and release of the crystal is effected is best seen in Figures 3 and 4, and comprises, in general, an eccentric 13 keyed to the engine crankshaft 7 above the upper main bearing, and a motion transmitting connection consisting of a sleeve 14 surrounding the eccentric and in which the eccentric is journaled, a tappet 15 connected at one end to the sleeve, and a lever 16 against which the other end of the tappet bears and which acts upon the crystal.

More specifically, the polycrystalline piezoelectric element or crystal 12 comprises a pair of substantially cylindrical pieces 17 and 17' of barium titanate or the like confined in end to end relationship in a substantially U-shaped holder 18. The legs 19 and 20 of the holder constitute abutments between which the crystal elements are endwise compressed, while the bight portion 21 of the holder cooperates with its legs to define a housing that encloses and protects the crystal. Outwardly turned feet 22 on the ends of the legs of the holder provide lugs which are fastened to the crankcase by means of screws 23.

The lever 16 has a transverse ridge 24 intermediate its ends which provides a fulcrum rockably seated on the abutment 19 on the crystal holder and which divides the lever into a short arm 26 and a long arm 27. A pin 28 fixed to the abutment 19 and projecting inwardly therefrom engages in a loosely fitting hole in the lever to prevent displacement of the lever out of engagement with the abutment. The short arm 26 of the lever bears against the adjacent end of the crystal element, while its long arm bears against the outer end of the tappet 15. A set screw 30 threaded through the abutment 20 and engaged against the end of the crystal remote from the lever urges the crystal against the short arm of the lever to hold the arms of the lever bowingly flexed about the fulcrum ridge 24 and thus maintain the crystal element under an endwise compressive preload.

Surrounding the upper end of the crankshaft, and the eccentric and sleeve thereon, is an annular upwardly projecting oil reservoir 32 which is preferably integral with the crankcase wall and which has an integral boss 33 protruding from one side thereof, adjacent to the long arm of the lever. The tappet 15 is axially slidable in a bore in the boss 33, the axis of which is radial to the axis of the crankshaft. The inner end of the tappet may have a socket connection to the sleeve 14 so that the sleeve provides a non-rotating connection between the eccentric and the tappet.

The two remote ends of the cylindrical crystal pieces 17 and 17' are grounded through the lever and the set screw, respectively, while their adjacent ends are in contact with a "hot" terminal member 35 that projects through the bight portion of the holder and is insulated therefrom to provide a stationary input electrode 36. Lateral displacement of the crystal pieces in the holder is prevented by means of an insulating tube 37 which surrounds the crystal and is secured to the holder in any suitable manner.

It will be apparent that as the crankshaft rotates, the eccentric, acting through the tappet, rocks the lever back and forth about its fulcrum, applying increasing compressive force to the crystal during one half of each revolution of the crankshaft and relaxing the compressive force during the other half revolution. Thus during the first half revolution of the crankshaft a voltage of one sign builds up across the terminals of the crystal element, reaching its peak value when compression is at a maximum; and during the second half revolution a voltage of the opposite sign builds up across the crystal, reaching its peak when compressive force upon the crystal falls to the minimum value.

In the case of a single cylinder engine, the peak voltage of one sign is applied to the spark plug at the proper time just before the conclusion of the compression stroke, while that of the other sign is grounded off of the crystal. Such distribution of the voltages produced across the crystal element is provided for by the distributor of this invention, which comprises in general, the stationary input electrode 36, a stationary output electrode 40 connected with the "hot" terminal 11 of the spark plug, a grounded stationary electrode 41, a rotor disc 38 secured to the crankshaft for rotation therewith, and a bridging conductor or shunt 39 on the rotor which cooperates with the stationary electrodes.

The distributor mechanism may be enclosed in a housing comprising a box-like member 61 secured to the top wall of the crankcase and providing an upright wall 62 extending around the distributor mechanism, and a cover 63 secured across the top of the box-like member. The grounded stationary electrode 41 may comprise a screw 64 extending through the wall 62 and projecting inwardly therefrom to have its tip located closely adjacent to the edge of the rotor disc. The output electrode may likewise be secured in the wall 62 but is well insulated therefrom and is connected by means of a conductor 65 with the high tension terminal 11 of the spark plug.

The distributor rotor 38 comprises a circular disc of insulating material coaxially secured to the upper end of the crankshaft, as by a coaxial screw 42 threaded into the crankshaft. As best seen in Figure 2, axially inward displacement of the disc is prevented by a spacer sleeve 43 keyed on the outer end of the crankshaft and confined between the disc and the eccentric, and the disc is constrained to rotate with the crankshaft by means of a pin 44 pressed into an axial well in the spacer sleeve and projecting outwardly into the disc.

The spacer sleeve cooperates with an outwardly facing shoulder 67 on the crankshaft and with the oil reservoir 32 on the upper crankcase wall to define an oil chamber

68 to which oil can be admitted from the crankcase interior through a bore 69, for lubrication of the tappet and the rotating connection between the eccentric 13 and the sleeve 14. An annular resilient oil seal 70 is confined in an annular recess in the front of the collar and closely embraces the spacer sleeve.

The bridging conductor or shunt 39 is a flat, substantially C-shaped or U-shaped strip of conductive metal carried by the rotor. Preferably the rotor disc is laminated and the shunt is sandwiched between laminations thereof, with end portions 46 and 47 of the shunt exposed at circumferentially spaced apart locations at the edge of the disc to provide movable electrodes. The diameter of the rotor disc is such that its edge is closely adjacent to the stationary input electrode 36, and the stationary output electrode 40 and the grounded elecrode 41 are also located adjacent to the edge of the rotor disc for circuit making cooperation with the movable electrodes 46 and 47.

The input and output electrodes 36 and 40 are circumferentially spaced apart a substantial distance to avoid the possibility of a direct sparking discharge from the input electrode to the output electrode at a time of peak voltage across the piezoelectric element, and the output electrode 40 is located ahead of the input electrode 36 in the direction of rotor rotation. The conductive shunt 39 serves to connect these electrodes in circuit with one another at the proper time for firing the plug.

If the movable electrodes 46 and 47 of the shunt were brought into circuit making juxtaposition with both the input and the output electrodes simultaneously, a sparking discharge from the input electrode to the leading shunt electrode 46 would take place as said shunt electrode approached the input electrode, dissipating some of the charge on the piezoelectric element in charging the shunt. Unless the shunt was very well insulated the charge on the shunt could leak away in substantial part before the trailing shunt electrode 47 moved close enough to the output electrode to permit the voltage on the piezoelectric element to jump both gaps between the electrodes and the shunt in series, and establish a circuit to the spark plug, and the plug would not fire.

With the apparatus of this invention the shunt or bridging conductor is first brought into circuit making juxtaposition to the output electrode, and after such relationship has been established, and while it is being maintained, the shunt is then also brought into circuit making juxtaposition to the input electrode. Hence the spark plug circuit through the shunt is completed before the shunt is moved into a position in which it can discharge the piezoelectric element, and the shunt merely serves as a conductive path along which the charge on the piezoelectric element moves to the plug, so that the amount of insulation that is required around the shunt is not critical and may be relatively small.

In the apparatus of this invention the circumferential distance between the leading edges of the movable shunt electrodes 46 and 47 is less than the circumferential distance between the stationary input and output electrodes, so that as the shunt revolves in its orbit the trailing movable electrode 47 comes into circuit making juxtaposition to the output electrode 40 before the leading electrode surface 46 moves into such relationship with the input electrode. (See Figure 5, and not that the direction of rotor rotation is assumed to be clockwise.) However, the trailing movable electrode 47 has a greater circumferential length than the leading movable electrode 46, and the trailing edges of the movable electrodes are spaced apart by a distance equal to the circumferential distance between the input and output electrodes, so that circuit making juxtaposition of the shunt with said two stationary electrodes is established and maintained during the interval that the plug is intended to fire. (See Figure 6.)

It will be obvious that the rotational position of the eccentric 13 must be coordinated with that of the shunt in order to insure that the peak voltage used for firing the plug will appear at the proper time in the engine cycle and will be applied to the spark plug at the proper moment. It will also be understood that peak voltage of either sign may be utilized for firing the plug.

The unused peak voltage is grounded off of the piezoelectric element by means of a second conductive shunt 49 on the insulating rotor, having a substantially annular inner portion 50 that coaxially embraces and contacts the outer end of the crankshaft, and a stem like portion 51 that projects radially from the inner portion and terminates in an electrode surface 52 that is exposed at the edge of the rotor disc, diametrically opposite the leading electrode surface 46 of the bridging conductor. It will be apparent that electrode surface 52 is carried into circuit making juxtaposition to the input electrode 36 at the time when the unused peak voltage appears across the piezoelectric element, and the shunt 49 therefore discharges such voltage from the crystal to the crankshaft, to which the inner portion 50 of the shunt is electrically connected and which is of course grounded. Such grounding off of the unused peak voltage across the crystal is illustrated in Figure 8.

In a single cylinder four-cycle engine in which the eccentric 13 and rotor 38 are mounted on the crankshaft, there will be two peak voltages of each sign across the piezoelectric element, corresponding to the two crankshaft revolutions during each engine cycle. Hence the plug will fire twice during each cycle, once at the usual time immediately before the downward power stroke of the piston, and again just before the downward intake stroke. The latter firing is of no consequence since it occurs toward the end of the exhaust stroke, but those skilled in the art will readily recognize that it can be avoided, if desired, by mounting the eccentric and rotor on the camshaft, which makes only one revolution during each engine cycle.

The grounded stationary electrode 41 prevents an additional undesired firing of the spark plug, which could occur as the leading electrode surface 46 of the bridging conductor 39 came into circuit making juxtaposition to the output electrode 40. As the trailing electrode surface 47 moves past the input electrode 36, a fraction of a revolution after the spark plug has been fired, the bridging conductor can accumulate a charge from the piezoelectric element. The rotational position of the rotor at the time this charge is picked up is illustrated in Figure 7. If this charge is not bled off of the bridging conductor before its leading electrode surface 46 passes the output electrode 40, the shunt will discharge itself through the spark plug at that time, for even though the charge on the shunt is relatively small, it would be applied to the spark plug at a time when pressure in the cylinder is relatively very low, so that under some conditions it could fire the plug, causing serious pre-ignition.

However, with the grounded electrode 41 located behind the input electrode and ahead of the output electrode along the orbit of the movable electrodes, any charge picked up by the bridging conductor as its trailing electrode passes the input electrode is bled off directly to ground through the grounded electrode before the shunt returns to circuit making juxtaposition to the output electrode, thus preventing undesired firing of the spark plug. The position of the rotor during such discharging of the shunt is illustrated in Figure 8.

The location of the grounded electrode 41 along the orbit of the movable electrodes is in no wise critical, so long as it is in the portion of the orbit just specified, although, like the input and output electrodes, it must of course be disposed closely adjacent to said orbit for circuit making cooperation with the movable electrodes.

From the foregoing description taken together with the

accompanying drawings it will be apparent that this invention provides means for applying a peak voltage appearing across an alternately compressed and relaxed piezoelectric element to a spark plug at a predetermined time in the engine cycle, without having undesired leakage to ground of the charge on the piezoelectric element, and without requiring very heavy insulation of the movable distributor shunt; and it will also be apparent that the invention provides for grounding off the unused peak voltage from the piezoelectric element and avoids undesired firing of the plug.

What is claimed as my invention is:

1. An ignition system for a reciprocating internal combustion engine, of the type comprising a polycrystalline piezoelectric element having a grounded side and a high tension terminal, means for effecting alternate compression and relaxation of the piezoelectric element in timed relation to rotation of the engine crankshaft, a stationary output electrode on the engine connected with the high tension terminal of a spark plug, and an orbitally movable conductive distributor member carried by a rotatable part on the engine for electrically connecting the output electrode with a stationary input electrode connected with the high tension side of the piezoelectric element at the proper instant in the engine cycle for firing the plug: said igniter system being characterized by the fact that the input electrode and the output electrode are disposed adjacent to the orbit of the distributor and are spaced apart circumferentially around said orbit; and further characterized by the fact that said distributor member has circumferentially spaced apart surfaces so disposed that during each orbital revolution of the distributor one of said surfaces is in circuit making juxtaposition to the output electrode prior to, as well as during the time that the other surface is in such juxtaposition to the input electrode, so that the high tension charge across the piezoelectric element can not leak to ground through the distributor prior to completion of the circuit through the spark plug.

2. An ignition system for a reciprocating internal combustion engine, of the type comprising an input electrode connected with one side of a piezoelectric element the other side of which is grounded, an output electrode connected with the high tension terminal of a spark plug, means for effecting alternate compression and relaxation of the piezoelectric element in timed relation to rotation of the engine crankshaft, and distributor means including a bridging conductor for electrically bridging the electrodes, said ignition system being characterized by the provision of: means including an orbitally movable crankshaft driven member for effecting, at the beginning of the portion of each engine cycle at which ignition is to occur, sequential circuit making juxtaposition first between the output electrode and the bridging conductor and then, while said established juxtaposition between the bridging conductor and the output electrode is being maintained, between the bridging conductor and the input electrode.

3. In an ignition system for a reciprocating internal combustion engine, of the type comprising a spark plug having a high tension terminal, a polycrystalline piezoelectric element having a grounded side and a high tension terminal, and means for effecting alternate compression and relaxation of the piezoelectric element in timed relation to rotation of a rotatable part on the engine, distributor means for applying a high tension voltage appearing across the piezoelectric element to the spark plug during a predetermined interval in the engine cycle to effect firing of the plug during said interval, said distributor means comprising: a stationary input electrode on the engine connected with the high tension side of the piezoelectric element, spaced to one side of the axis of said rotatable part; a rotor of insulating material carried by said rotatable part on the engine; a bridging conductor fixed on said rotor for orbital revolution therewith and having a pair of circumferentially spaced apart exposed electrode surfaces so disposed as to move in a common orbit during rotation of the rotor, which orbit is closely adjacent to the input electrode; and a stationary output electrode on the engine closely adjacent to the orbit of the electrode surfaces on the bridging conductor and connected with the high tension terminal of the spark plug, said output electrode being circumferentially spaced from the input electrode by a distance such that one of said electrode surfaces of the bridging conductor is in circuit making juxtaposition to the output electrode both shortly before and during the interval that the other electrode surface is in such juxtaposition to the input electrode, so that the high tension charge across the piezoelectric element can not leak to ground through the bridging conductor prior to completion of a circuit through the spark plug.

4. The ignition system of claim 3, further characterized by the provision of a grounded stationary electrode on the engine closely adjacent to the orbit of said electrode surfaces on the bridging conductor and circumferentially spaced from both the input and the output electrodes, by which grounded electrode any charge on the bridging conductor, derived from the input electrode after firing of the spark plug, may be discharged to ground, to prevent undesired firing of the plug as the bridging conductor returns to circuit making juxtaposition with the output electrode.

5. The ignition system of claim 2, further characterized by means including said orbitally movable crankshaft driven member and a grounded electrode for effecting grounding of the bridging conductor during a portion of each engine cycle subsequent to said designated portion thereof, to discharge from the bridging conductor any charge thereon derived from the input electrode after firing of the spark plug.

6. An ignition system for a reciprocating internal combustion engine, of the type comprising a spark plug having a high tension terminal connected with an output electrode, a polycrystalline piezoelectric element having a grounded side and a high tension side connected with an input electrode, means for effecting alternate compression and relaxation of the piezoelectric element in timed relation to rotation of a rotatable part on the engine to cause peak voltages of opposite signs to appear across the piezoelectric element at maximum values of compression and relaxation, and distributor means including a bridging conductor for electrically bridging the electrodes to fire the spark plug when one of said peak voltages appears across the piezoelectric element, said ignition system being characterized by the provision of: means including an orbitally movable crankshaft driven member for effecting, at the beginning of that portion of each engine cycle at which firing of the spark plug is to occur, sequential circuit making juxtaposition first between the bridging conductor and output electrode and then, while said established juxtaposition between the bridging conductor and the output electrode is being maintained, between the bridging conductor and the input electrode; and means including said orbitally movable crankshaft driven member and another conductor for grounding the input electrode during that portion of each engine cycle when a peak voltage of the opposite sign appears across the piezoelectric element.

7. In an ignition system for a reciprocating internal combustion engine, of the type comprising a spark plug having a high tension terminal, a polycrystalline piezoelectric element having a grounded side and a high tension side, and means for effecting alternate compression and relaxation of the piezoelectric element in timed relation to rotation of a rotatable part on the engine to cause peak voltages of opposite signs to appear across the piezoelectric element at maximum values of compression and relaxation, distributor means for applying one of such peak voltages to the spark plug during a predetermined interval in the engine cycle to effect firing of the plug during said interval, said distributor means comprising: a stationary input electrode spaced a distance from the axis

of the rotatable part and connected with the high tension side of the piezoelectric element; a stationary output electrode connected with the high tension terminal of the spark plug, spaced substantially the same distance from the axis of the rotating part and circumferentially spaced from the input electrode; a rotor of insulating material coaxially carried by said rotating part for rotation therewith; and a bridging conductor on said rotor having a pair of exposed circumferentially spaced apart electrode surfaces spaced from the rotor axis by a distance substantially equal to the spacing therefrom of said stationary electrodes, for circuit making cooperation with the stationary electrodes, the circumferential spacing of the leading edges of said surfaces differing from that of said stationary electrodes by an amount such that as the rotor rotates one of said electrode surfaces moves into circuit making juxtaposition to the output electrode before the other electrode surface moves into such juxtaposition to the input electrode, but said electrode surfaces having circumferential lengths such that through an immediately subsequent portion of their orbit they are simultaneously juxtaposed to both of said stationary electrodes, so that a circuit through the piezoelectric element and the spark plug is not set up until the bridging conductor is connected in the spark plug circuit, thus avoiding discharge of the piezoelectric element into the bridging conductor before the spark plug circuit is completed.

8. The ignition system of claim 7, further characterized by the fact that the output electrode is spaced ahead of the input electrode in the direction of rotor rotation; and further characterized by a grounded stationary electrode on the engine, spaced substantially the same distance from the axis of the rotatable part as the input and output electrodes, and circumferentially spaced behind the input electrode in the direction of rotor rotation so that any charge picked up by the bridging conductor as said one electrode surface thereon moves into circuit making juxtaposition to the input electrode will be discharged to ground through the grounded electrode instead of causing firing of the plug at an undesired time when the other electrode surface on the bridging conductor moves into circuit making juxtaposition to the output electrode.

9. The ignition system of claim 7 further characterized by a second bridging conductor on the rotor having an electrode surface disposed at the same distance from the rotor axis as said electrode surfaces on the first designated bridging conductor, and substantially diametrically opposite said other electrode surface on the first designated bridging conductor, for circuit making cooperation with the input electrode during intervals when peak voltages of the opposite sign appear across the piezoelectric element; and means for grounding the second bridging conductor to discharge the piezoelectric element of such peak voltages of opposite sign.

10. In an ignition system for a reciprocating internal combustion engine, of the type comprising a spark plug having a high tension terminal, a polycrystalline piezoelectric element having a grounded side and a high tension side, and means for effecting alternate compression and relaxation of the piezoelectric element in timed relation to rotation of a rotatable part on the engine to cause peak voltages of opposite signs to appear across the piezoelectric element at maximum values of compression and relaxation thereof, distributor means for applying one of such peak voltages to the spark plug during a predetermined interval in the engine cycle to effect firing of the plug during said interval, said distributor means comprising: a rotor of insulating material carried by said rotating part for rotation therewith; a bridging conductor on said rotor having a pair of exposed electrode surfaces lying in a common orbit and circumferentially spaced from one another; a stationary output electrode connected with the high tension terminal of the spark plug and located adjacent said orbit for circuit making cooperation with said electrode surfaces on the bridging conductor; a stationary input electrode connected with the high tension side of the piezoelectric element and located adjacent to said orbit, circumferentially spaced behind the output electrode in the direction of rotor rotation by a distance such that at one point in their orbit the leading and trailing electrode surfaces on the bridging conductor are simultaneously in circuit making juxtaposition to the input and output electrodes to connect the spark plug in circuit with the piezoelectric element, and thus effect firing of the spark plug; and a stationary grounded electrode located adjacent to said orbit and circumferentially spaced behind the input electrode and ahead of the output electrode in the direction of rotor rotation, by which grounded electrode the bridging conductor is discharged of any charge its trailing electrode surface may pick up as it passes orbitally through circuit making juxtaposition with the input electrode after the spark plug is fired, to prevent any such charge on the bridging conductor from causing undesired sparking of the spark plug when the leading electrode surface moves back into circuit making juxtaposition to the output electrode.

11. The ignition system of claim 10 further characterized by the fact that the leading edges of the electrode surfaces of the bridging conductor are spaced apart by a circumferential distance less than that between the input and output electrodes, so that the bridging conductor moves into circuit making juxtaposition to the output electrode before it moves into such juxtaposition to the input electrode, thus avoiding the possibility that the bridging conductor will pick up a charge from the piezoelectric element and leak it to ground before the spark plug circuit is completed.

12. The ignition system of claim 10, further characterized by a second conductor on the rotor having an exposed electrode surface diametrically opposite the leading electrode surface on the bridging conductor and lying on the orbit of said electrode surfaces on the bridging conductor; and further characterized by means for grounding said second conductor so that as its said electrode surface moves into circuit making juxtaposition to the input electrode said second conductor will discharge the other, unused peak voltage from the piezoelectric element.

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