

[54] **PNEUMATICALLY OPERATED ACTUATOR**  
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[73] Assignee: **Robertshaw Controls Company, Richmond, Va.**  
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**Related U.S. Application Data**

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[52] U.S. Cl. ....91/222, 91/398, 91/469  
[51] Int. Cl. ....F01L 21/04, F15B 13/042  
[58] Field of Search.....91/222, 398, 469

[56] **References Cited**

**UNITED STATES PATENTS**

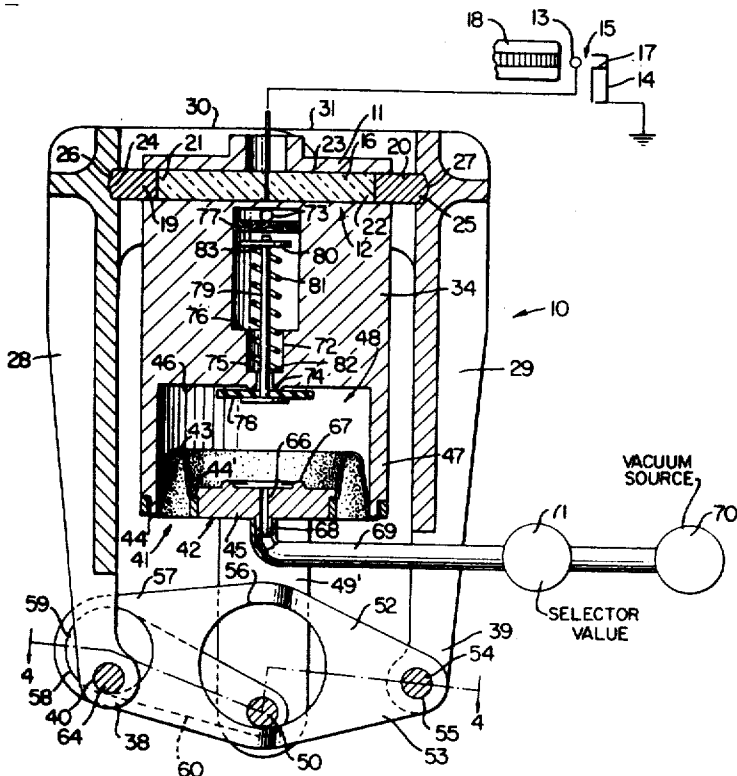
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[57] **ABSTRACT**

A pneumatically actuated operator for altering the stresses in a piezoelectric crystal means for spark igniting purposes and the like, the actuator having a movable wall that cooperates with a housing to define a chamber therebetween. The actuator has a first passage provided with a valve seat leading to the chamber and is adapted to be interconnected to a pneumatic source. The actuator has a second passage provided with a valve seat leading to the chamber and is adapted to be interconnected to the atmosphere. A single valve member is movably carried by the housing for opening the valve seat of the first passage and closing the valve seat of the second passage when the movable wall is in a predetermined deactuated stroke position thereof. The single valve member is adapted to close the valve seat of the first passage and open the valve seat of the second passage when the movable wall is in a predetermined actuated stroke position thereof whereby the movable wall is cycled between the predetermined positions thereof as long as the pneumatic source is interconnected to a chamber.

**2 Claims, 8 Drawing Figures**



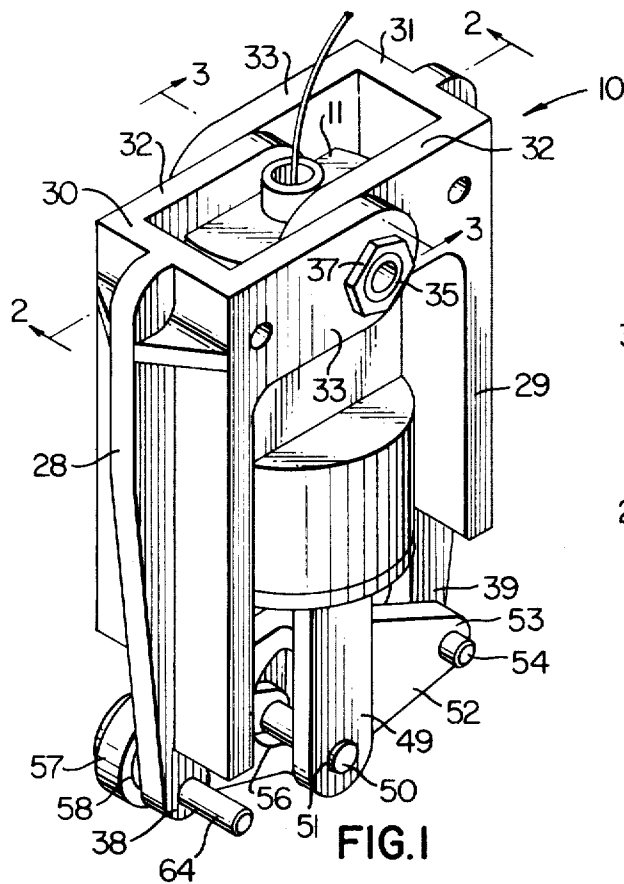
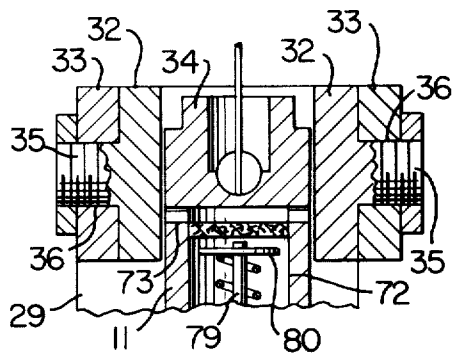


FIG. 3

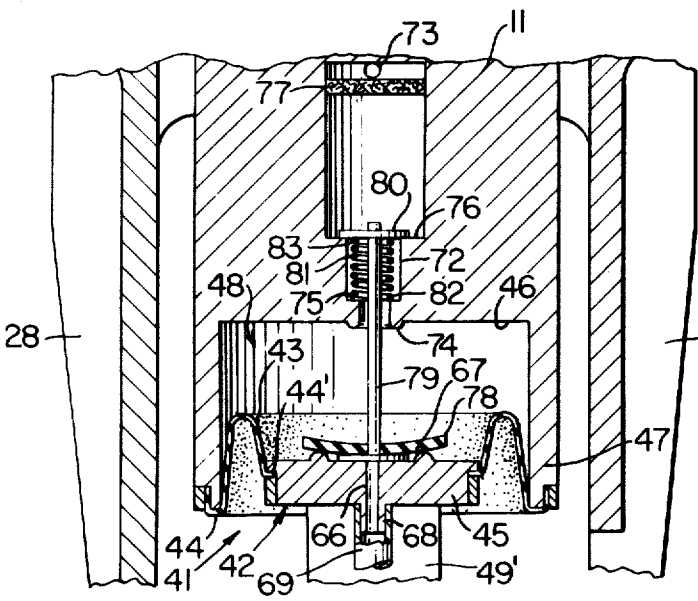
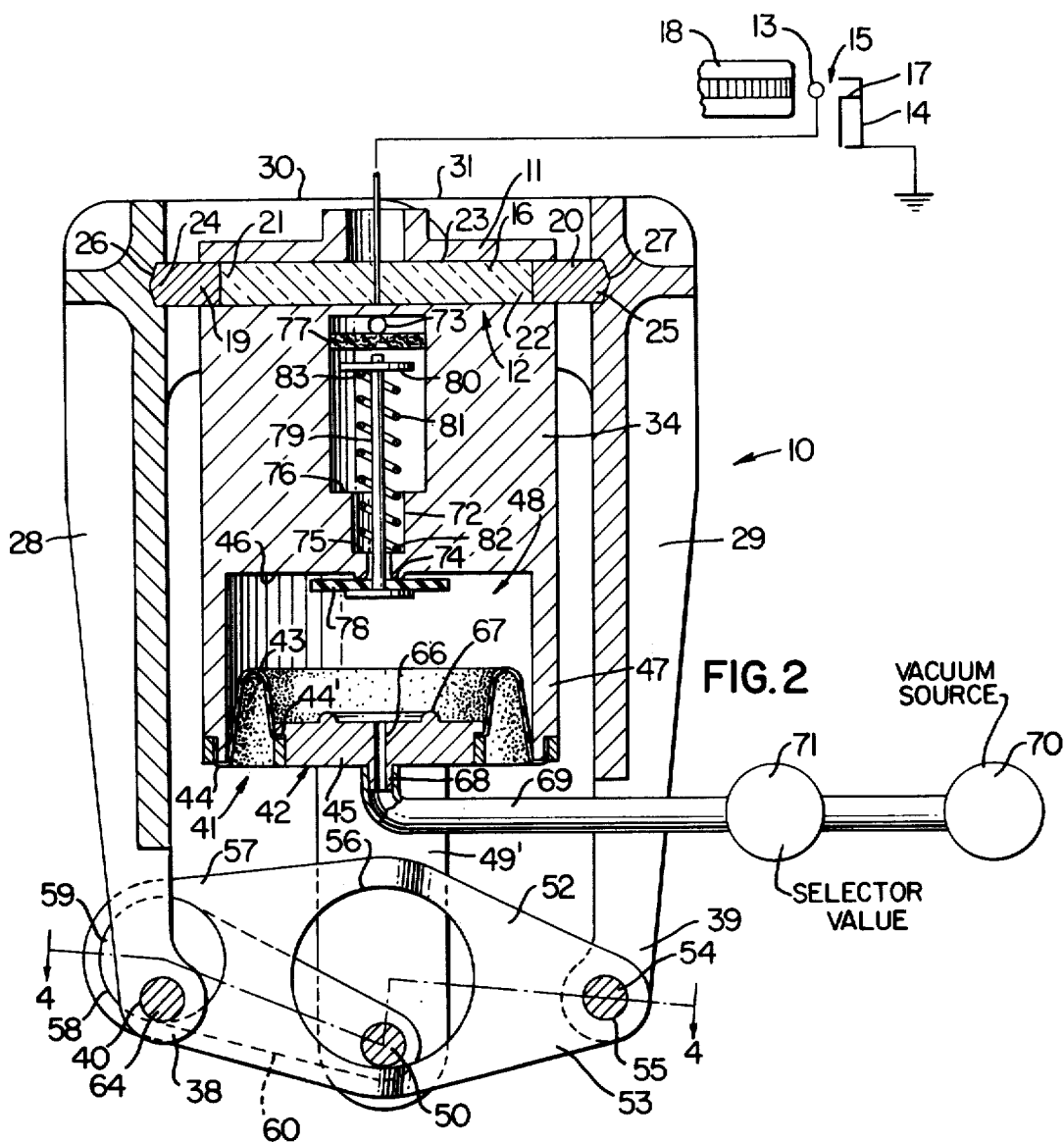
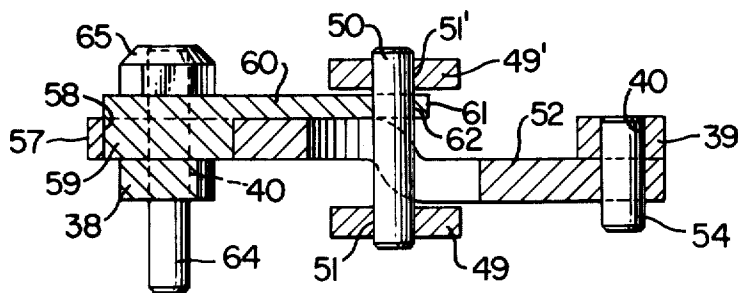


FIG. 7



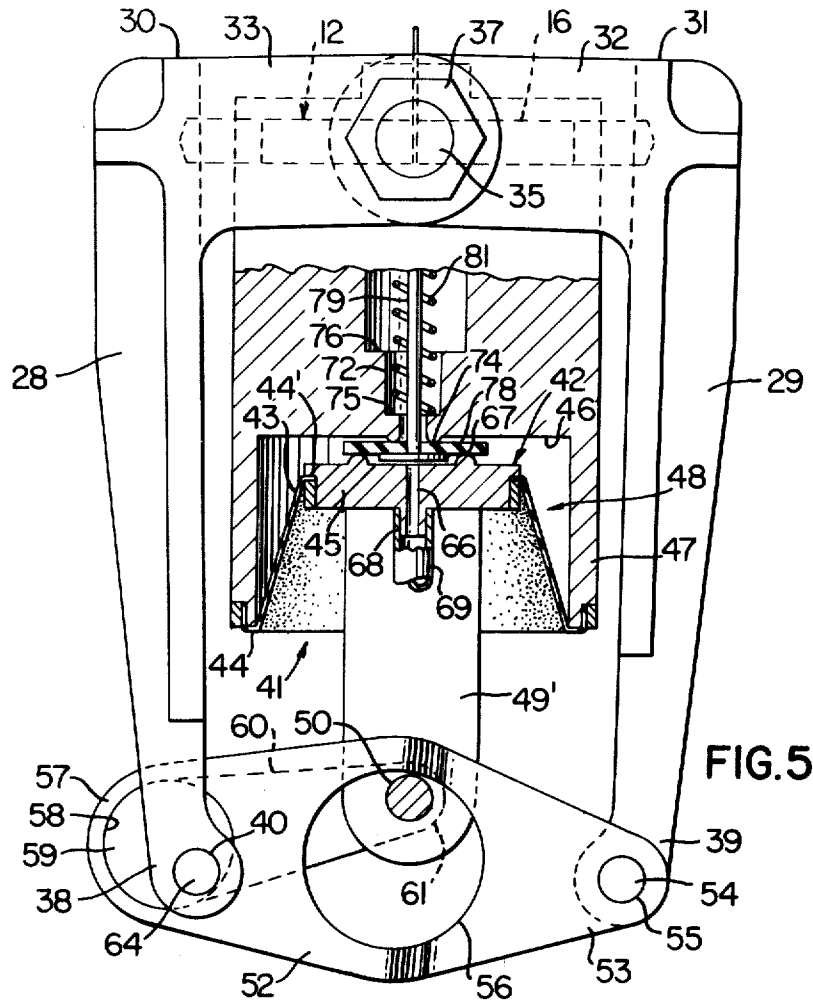


FIG. 5

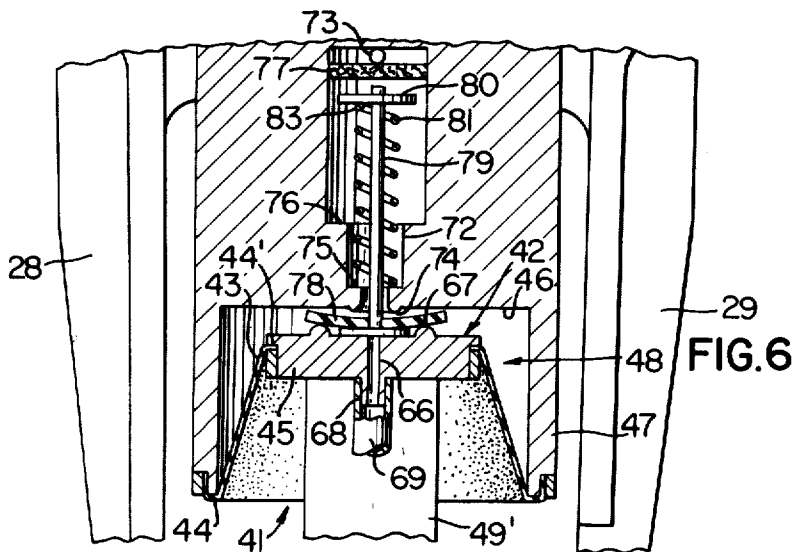


FIG. 6

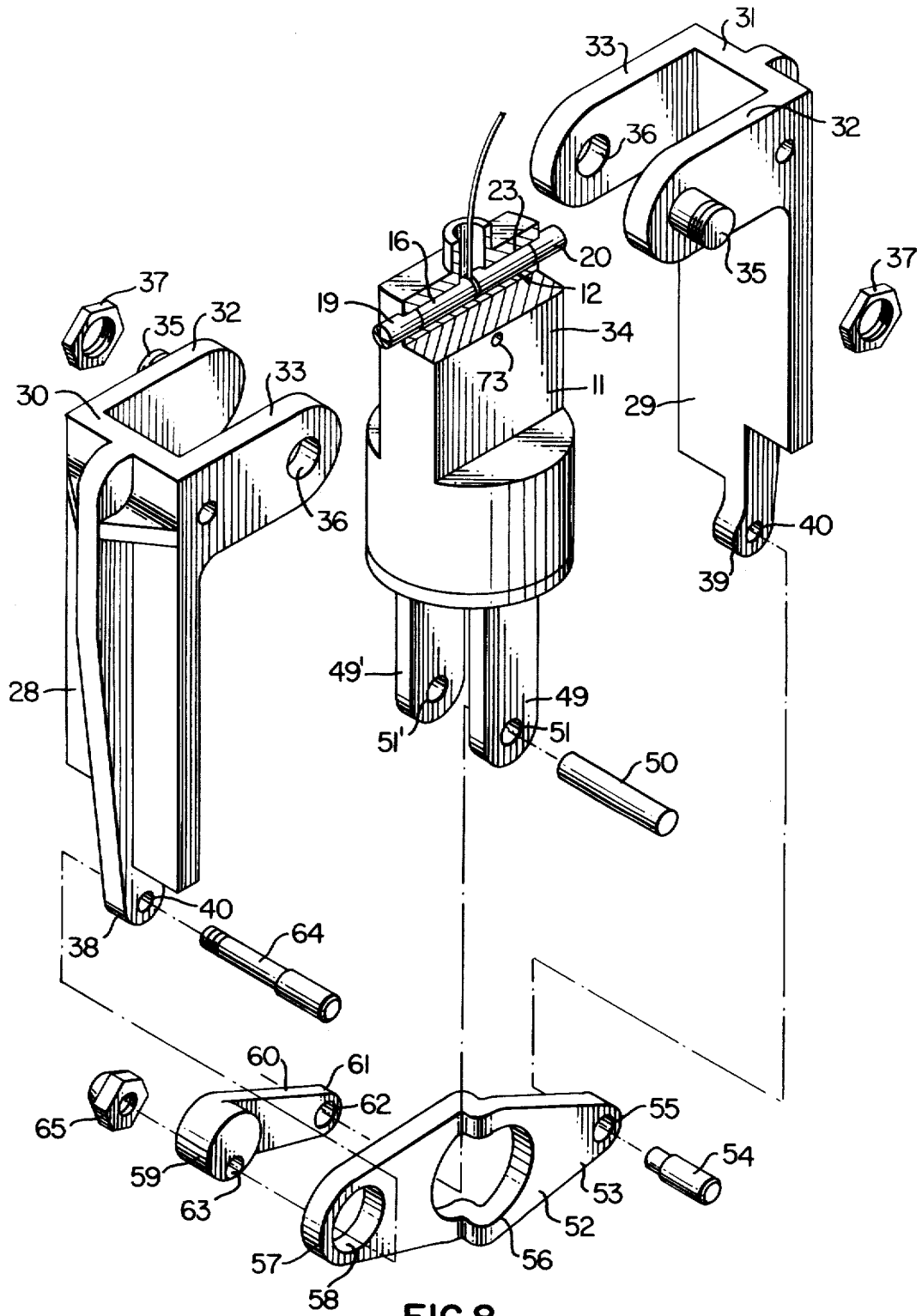


FIG. 8

**PNEUMATICALLY OPERATED ACTUATOR**

This application is a divisional U.S. Pat. application of its co-pending parent application, Ser. No. 749,745, filed Aug. 2, 1968, now U.S. Pat. No. 3,634,706, and is assigned to the same assignee to whom the parent application is assigned.

This invention relates to improved apparatus for altering the stresses in a piezoelectric crystal means to cause sparking for ignition purposes or the like.

It is well known that a piezoelectric crystal means can have the internal stresses therein altered in a manner to produce an electrical potential at an electrode interconnected to such crystal means whereby when the magnitude of the potential differential between that electrode and another electrode reaches a predetermined point, sparking is created across the spark gap between such electrodes and such sparking can be utilized to ignite the gaseous fuel and the like issuing from a burner means disposed closely adjacent the spark gap.

Therefore, it is a feature of this invention to provide improved means for altering the stresses of such a crystal means.

In particular, the illustrated embodiment of this invention has the piezoelectric crystal means disposed between the opposed ends of a pair of pivotally movable arms that have their outer free ends moved toward and away from each other by a pneumatically operated actuator interconnected thereto by cam means whereby the crystal means is compressed as the arms move toward each other and has the compression thereon relieved as the arms move away from each other, the pneumatically operated actuator of this invention automatically cycling itself between its deactuated position and its actuated position as long as a pneumatic source is interconnected thereto whereby it can be seen that the actuator of this invention can be utilized for purposes other than operating the ignition means of this invention.

Accordingly, it is an object of this invention to provide an improved pneumatically operated actuator having one or more of the novel features set forth above or hereinafter shown or described.

Other objects, uses and advantages of this invention are apparent from a reading of this description which proceeds with reference to the accompanying drawings forming a part thereof and wherein:

FIG. 1 is a top perspective view of the improved piezoelectric crystal actuator of this invention.

FIG. 2 is an enlarged, cross-sectional view taken on line 2—2 of FIG. 1 and schematically illustrates the ignition system of this invention, the pneumatically operated actuator being disposed in its predetermined deactuated stroke position.

FIG. 3 is a fragmentary cross-sectional view taken substantially on line 3—3 of FIG. 1.

FIG. 4 is a cross-sectional view taken substantially on line 4—4 of FIG. 2.

FIG. 5 is a view similar to FIG. 2 and illustrates the pneumatically operated actuator in its predetermined actuated stroke position.

FIG. 6 is a view similar to FIG. 5 and illustrates the pneumatically operated actuator as it starts to move from its predetermined actuated stroke position back to its predetermined deactuated stroke position.

FIG. 7 is a view similar to FIG. 6 and illustrates the pneumatically operated actuator just before it reaches its predetermined deactuated stroke position.

FIG. 8 is an exploded perspective view of the various parts of the actuating structure of FIG. 1.

While the various features of this invention are hereinafter described and illustrated as being particularly adapted to provide sparking for igniting burner means or the like, it is to be understood that the various features of this invention can be utilized singly or in any combination thereof to provide means for altering stresses in piezoelectric crystal means for any desired purpose.

Therefore, this invention is not to be limited to only the embodiment illustrated in the drawings because the drawings are merely utilized to illustrate one of the wide variety of uses in this invention.

Referring now to FIGS. 1 and 2, the improved ignition means of this invention is generally indicated by the reference numeral 10 and comprises a housing means or frame means 11 carrying a piezoelectric crystal means or stack, generally indicated by the reference numeral 12, for creating an electrical potential at an electrode 13 that is spaced from a grounded pilot burner means 14 and defines a spark gap 15 therewith. In this manner, when the stresses in the piezoelectric crystal means 16 of the crystal stack 12 are altered in the manner hereinafter described and the potential difference between the electrodes 13 and 14 reaches a certain magnitude, electrical sparking is created across the spark gap 15 to ignite fuel issuing from an outlet means 17 of the pilot burner means 14, the ignited pilot burner means 14 now being adapted to ignite fuel issuing from a main burner means 18 disposed adjacent thereto.

The crystal stack 12 includes a pair of pressure pad or anvil means 19 and 20 respectively being disposed against the opposed ends 21 and 22 of the crystal means 16 and projecting outwardly from the opposed ends of a bore means 23 passing through the housing means or frame means 11 and telescopically receiving the crystal means 16 and pressure pad means 19 and 20 therein.

The pressure pads 19 and 20 each has the outer ends 24 and 25 thereof received in recesses 26 and 27 formed in a pair of arms 28 and 29 pivotally mounted together at their upper ends 30 and 31.

In particular, reference is now made to FIGS. 3 and 8 wherein the arms 28 and 29 each has a pair of like ears 32 and 33 extending at right angles thereto and in spaced relation to receive the upper end 34 of the housing means or frame means 11 therebetween with the ear 33 of the arm 28 overlapping with the ear 32 of the arm 29 and with the ear 32 of the arm 28 overlapping with the ear 33 of the arm 29 as illustrated in FIGS. 1 and 3, the arms 28 and 29 being identical except that the arm 29 is turned 180° relative to the arm 28 as illustrated in FIG. 8.

The ears 32 of each arm 28 and 29 have outwardly extending threaded studs 35 adapted to be respectively received through openings 36 in the ears 33 of the arms 28 and 29 and be secured thereto by suitable nuts 37 as illustrated in FIGS. 1 and 3 whereby the arms 28 and 29 are effectively pivotally mounted to each other at the upper ends 30 and 31 thereof.

The lower ends 38 and 39 of the arms 28 and 29 each has a bore 40 passing therethrough to be operatively interconnected to the pneumatic actuator of this invention that is generally indicated by the reference numeral 41 in FIG. 2 and provides part of the housing means or frame means 11 previously described.

The pneumatically operated actuator 41 of this invention as illustrated in FIG. 2 comprises a movable wall means 42 formed from a flexible diaphragm 43 having its outer periphery 44 secured to the housing means 11 in any suitable manner and its inner end or periphery 44' secured to a plate member 45 whereby the movable wall means 42 cooperates with a cutout 46 in the lower end 47 of the housing means 11 to define a chamber 48 between the housing means 11 and the movable wall means 42.

The plate 45 of the movable wall means 42 has a pair of arms 49 and 49' extending outwardly therefrom in spaced relation and are adapted to receive a pivot pin 50 in like bores 51 and 51' formed at the lower ends thereof as illustrated in FIGS. 2 and 4.

A plate 52 has its right hand end 53 as illustrated in FIGS. 2 and 4 pivotally mounted to the lower end 39 of the arm 29 by a pivot pin 54 passing through the bore 40 in the arm 29 and an aligned bore 55 of the plate 52. A circular opening 56 passes through the medial portion of the plate 52 so as to telescopically receive the pin 50 of the actuator arms 49 and 49' as illustrated in FIGS. 2 and 4.

The left hand end 57 of the plate 52 has a circular bore 58 passing therethrough and rotatably receiving a cylindrical cam member 59 therein as illustrated in FIGS. 2 and 4, the cylindrical cam member 59 being integrally interconnected to a cam arm 60 that has its right hand end 61 pivotally mounted to the actuator arms 49 and 49' by the pin 50 passing through a bore 62 therein as illustrated in FIG. 4.

As illustrated in FIGS. 2 and 8, the cylindrical cam member 59 has a bore 63 passing therethrough in offset relation to the longitudinal axis of the cylindrical cam 59 and substantially tangent to the outer peripheral surface thereof. A pivot pin 64 is disposed in the offset bore 63 of the cam member 59 and is held in position by a nut 65 threaded thereon, the pivot pin 64 also passing through the bore 40 at the lower end 38 of the arm 28 so as to pivotally interconnect the arm 28 to the cam member 59.

When the actuator 41 is operated in a manner hereinafter described, the same cycles from its predetermined deactuated stroke position of FIG. 2 to its predetermined actuated stroke position of FIG. 5 whereby it can be seen that the actuator arms 49 and 49' are moved vertically upwardly from the position illustrated in FIG. 2 to the position illustrated in FIG. 5 whereby such movement of the cam arm 60 rotates the cylindrical cam member 59 in the circular bore 48 so as to rock or pivot the arm 28 toward the arm 29 to longitudinally compress the crystal stack 12 therebetween.

Conversely, when the actuator 41 moves from its actuated stroke position of FIG. 5 back to its deactuated stroke position of FIG. 2, the arms 28 and 29 are pivoted away from each other by the cam member 59 rotating in the bore 58 so that the previously described longitudinal compressive force on the crystal stack 12 is relieved whereby the crystal means 16 can longitudinally expand.

Thus, as the actuator 41 is reciprocated between its predetermined actuated stroke position and its deactuated stroke position in a manner hereinafter described, the arms 28 and 29 are pivoted toward each other and then away from each other to alternately apply a squeezing action and a squeeze relieving action on the crystal means 16 to cause sparking at the spark gap 15.

In particular, as the arms 28 and 29 are being pivoted toward each other to longitudinally compress the crystal means 16 therebetween, a potential is being created at the electrode 13 and when the potential differential between the electrode 13 and the grounded pilot burner means 14 reaches a predetermined magnitude, a discharge occurs across the spark gap 15 in the form of sparks which will tend to ignite fuel issuing from the outlet end 17 of the burner means 14. Such sparking at the spark gap 15 can take place one or more times during the longitudinal compressing of the crystal means 16 depending upon the amount of pivoting movement of the arms 28 and 29 toward each other. Conversely, as the arms 28 and 29 begin to pivot away from each other so as to relieve the longitudinal compressive force previously imposed on the crystal means 16, the expanding crystal means 16 is also having the stresses therein altered to cause sparking one or more times at the spark gap 15.

Therefore, it can be seen that a large compressive force can be imposed upon the crystal means 16 by the pivoting arm means 28 and 29 in much the same manner as provided by a nut cracker or the like.

The plate 45 of the actuator 41 has a passage means 66 formed centrally therethrough so as to be adapted to be disposed in fluid communication with the chamber 48, the plate 45 having an annular valve seat 67 surrounding the inner end of the passage means 66 and projecting into the chamber 48. The passage means 66 passes through a tubular extension 68 formed on the outside of the plate 45 between the arms 49 and 49' thereof so as to be telescoped within a flexible tubular conduit 69 that leads from a pneumatic source 70.

For example, the pneumatic source 70 is a vacuum pump so as to provide a vacuum source for operating the actuator 41. A selector valve 71 is disposed in the conduit means 69 intermediate the vacuum source 70 and the actuator 41 to selectively connect or disconnect the vacuum source 70 therefrom for a purpose hereinafter described.

Another passage means 72 is provided for the actuator 41 and is formed in the housing means or frame means 11 so as to interconnect an atmosphere port 73 with an annular valve seat 74 surrounding the passage means 72 and projecting into the chamber 48 of the actuator 41, the passage means 72 being stepped in the housing means 11 to define a pair of internal shoulder means 75 and 76.

A porous filtering material or member 77 is disposed in the passage means 72 intermediate the atmosphere port 73 and the valve seat 74 for filtering air flow through the passage means 72.

A flexible valve member 78 is movably carried by the housing means 11 and has a valve stem 79 projecting through the valve seat 74 into the passage means 72 and terminating at a fixed disc member 80 at the upper end thereof as illustrated in FIG. 2. A compression spring 81 is disposed in the passage means 72 and has one end 82 bearing against the shoulder 75 and the

other end 83 thereof bearing against the disc member 80 so as to normally tend to maintain the valve member 78 in sealing relationship against the valve seat 74 so as to close the passage means 72 from the chamber 48 of the actuator 41.

The operation of the actuator 41 for controlling the aforementioned squeezing action and subsequent squeeze relieving action on the crystal stack 12 will now be described.

When the housewife or the like desires to turn on the main burner means 18 of the cooking apparatus by operating the respective selector knob therefor (not shown) and the burner means 18 does not ignite because of the pilot burner means 14 being unlit, or when she actually notices that the pilot burner means 14 has been extinguished for some reason, the housewife or the like can effect the ignition of the pilot burner means 14 by causing the actuator 41 to repetitively cycle between its predetermined actuated stroke position of FIG. 2 by operating the selector means 71.

In particular, the selector valve 71 can be manually operated so that the housewife or the like must manually maintain the same in its "on" position for a desired length of time or the selector means 71 can be a timer operated valve means which when initially actuated will interconnect the vacuum source 70 to the actuator 41 for a predetermined period of time after the lapse of which the timer means will turn the valve means 71 to its "off" position to terminate the operation of the ignition means 10.

In any event, when the vacuum source 70 is initially interconnected to the actuator 41, it can be seen that since the valve member 78 is disposed against the valve seat 74, the vacuum source 70 can begin to evacuate the chamber 48 whereby the resulting pressure differential across the diaphragm 43 causes the movable wall means 42 to move upwardly from the position illustrated in FIG. 2 to the position illustrated in FIG. 5 whereby the arms 28 and 29 are pivoted toward each other to provide the aforementioned sparking at the spark gap 15. When the movable wall 42 reaches the position illustrated in FIG. 5, it can be seen that the valve seat 67 on the movable wall 42 now engages the valve member 78 to seal closed the valve seat 67 from the chamber 48 so that further evacuation thereof cannot take place as the vacuum source 70 is effectively disconnected from the chamber 48. However, because the valve seat 67 is relatively large in relation to the valve seat 74, the amount of vacuum increases under the valve member 78 so that the resulting pressure differential across the valve member 78 at the valve seats 67 and 74 causes the valve member 78 to be flexed downwardly into the valve seat 67 as illustrated in FIG. 6 in opposition to the force of the compression spring 81 so as to open the valve seat 74.

With the valve seat 74 now opened and with the valve seat 67 now closed by the flexed valve member 78 as illustrated in FIG. 6, the atmosphere is adapted to pass from the atmosphere port 73, through the passage means 72 and open valve seat 74, into the chamber 48 so that the decreasing pressure differential across the diaphragm 43 permits the movable wall 42 to move downwardly from the position illustrated in FIG. 6 to the piston illustrated in FIG. 7 by the force of the legs 28 and 29 being pivoted outwardly by the previously

compressed piezoelectric crystal means 12, the valve member 78 being carried therewith because of the aforementioned pressure differential across the valve member 78 whereby the valve stem 79 moves therewith and compresses the compression spring 81. However, when the movable wall 42 reaches the position illustrated in FIG. 7, the valve disc 80 bottoms out against the shoulder 76 of the housing means 11 to prevent further downward movement of the valve member 78 so that further downward movement of the movable wall 42 from the position illustrated in FIG. 7 to the position illustrated in FIG. 2 causes the valve seat 67 to move away from the valve member 78 and thereby open the passage means 66 to the chamber 48. When the movable wall 42 moves away from the valve member 78, the pressure differential across the valve member 78 ceases to exist whereby the compression spring 81 snaps the valve member 78 upwardly to the position illustrated in FIG. 2 to again seal closed the valve seat 74.

With the valve seat 74 now closed, the vacuum source 70 can now begin to evacuate the chamber 48 in the manner previously described to again move the movable wall 42 from its predetermined deactuated stroke position of FIG. 2 back to its predetermined actuated stroke position of FIG. 5.

Therefore, it can be seen that the actuator 41 will continue to cycle between its predetermined deactuated stroke position and its predetermined actuated stroke position as long as the vacuum source 70 is interconnected thereto by the selector valve means 71, such cycling of the actuator 41 causing the aforementioned cycling of the pivot arms 28 and 29 toward each other and away from each other to cause sparking at the spark gap 15 in the manner previously described.

Therefore, it can be seen that this invention not only provides an improved ignition means for a cooking apparatus or the like, but also this invention provides an improved pneumatically operated actuator for such an ignition means or the like.

Further, it can be seen that the pneumatically operated actuator of this invention can be used for purposes other than just with the spark igniting means of this invention.

What is claimed is:

1. A pneumatically operated actuator comprising a housing means carrying a movable wall that cooperates therewith to define a chamber therebetween, said actuator having a first passage means leading to said chamber and being adapted to be interconnected to a pneumatic source, said actuator having a second passage means leading to said chamber and being adapted to be interconnected to the atmosphere, a single valve member movably carried by said housing means for opening said first passage means and closing said second passage means when said movable wall is in a predetermined deactuated stroke position thereof and for closing said first passage means and opening said second passage means when said movable wall is in a predetermined actuated stroke position thereof whereby said movable wall is cycled between said predetermined positions thereof as long as said source is interconnected to said chamber, said first passage means passing through said movable wall and said second passage passing through said housing, and a

spring means carried by said housing means and being operatively interconnected to said valve member to tend to move said valve member to close said second passage means and open said first passage means.

2. A pneumatically operated actuator comprising a housing means carrying a movable wall that cooperates therewith to define a chamber therebetween, said actuator having a first passage means leading to said chamber and being adapted to be interconnected to a pneumatic source, said actuator having a second passage means leading to said chamber and being adapted to be interconnected to the atmosphere, and a single valve member movably carried by said housing means for opening said first passage means and closing said second passage means when said movable wall is in a predetermined deactuated stroke position thereof and for closing said first passage means and opening said second passage means when said movable wall is in a predetermined actuated stroke position thereof

whereby said movable wall is cycled between said predetermined positions thereof as long as said source is interconnected to said chamber, said first passage means passing through said movable wall and said second passage passing through said housing, said first passage means terminating at a first valve seat carried by said movable wall and projecting into said chamber, said valve member being flexible, said housing means having a second valve seat at the terminal end of said second passage means and projecting into said chamber so as to face said first valve seat whereby said valve member is movable between said seats, said first and second valve seats being annular and said first valve seat having a greater diameter than the diameter of said second valve seat whereby said valve member is adapted to be bowed away from seating engagement with said second valve seat when said first valve seat also seats against said valve member.

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