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3,071,730

SWITCHING SYSTEM FOR SELECTIVELY IONIZING GAS TUBES
BY RADIO FREQUENCY ENERGY UNDER CONTROL OF
MOVEABLE BLOCKING SHIELD

Filed Dec. 9, 1958

2 Sheets-Sheet 1

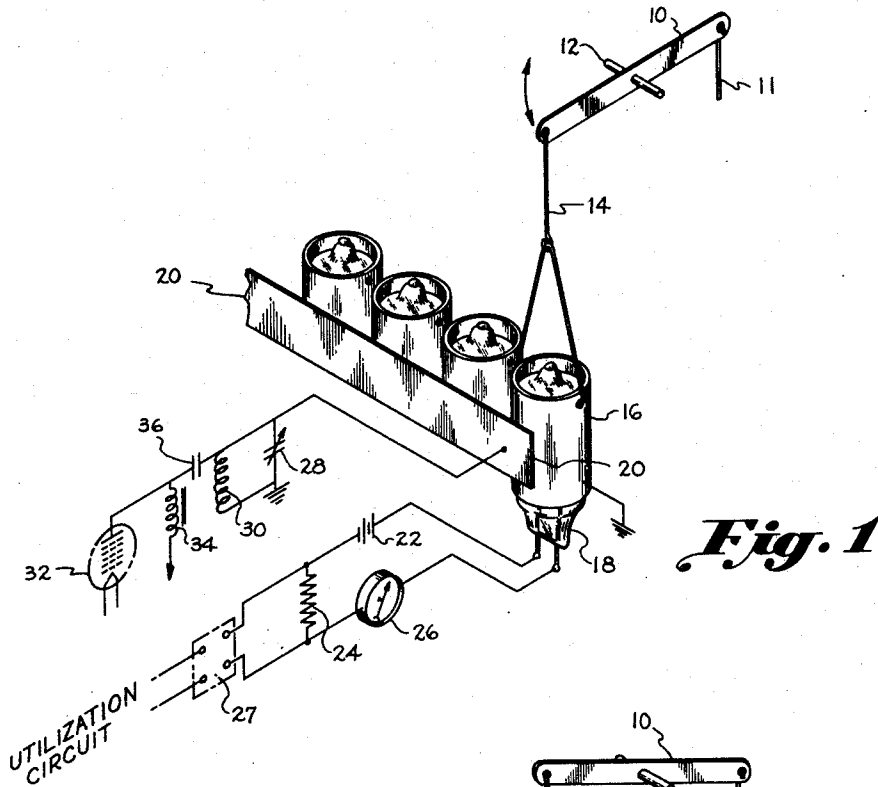
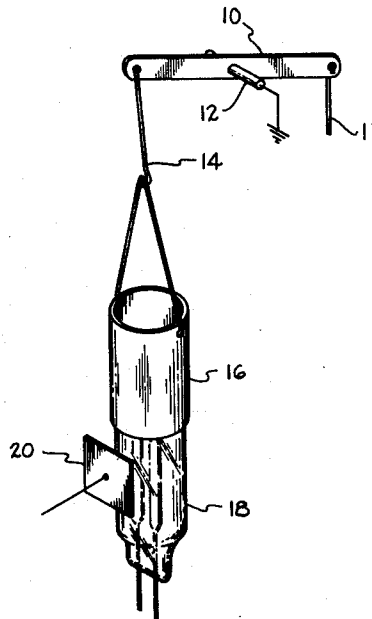


Fig. 2



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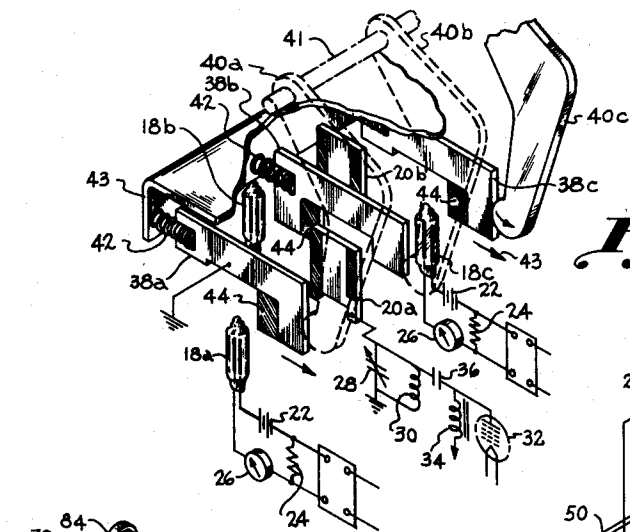


Fig. 3

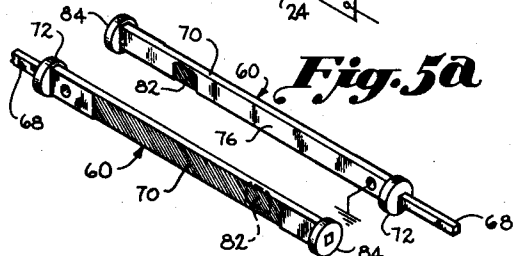


Fig. 5a

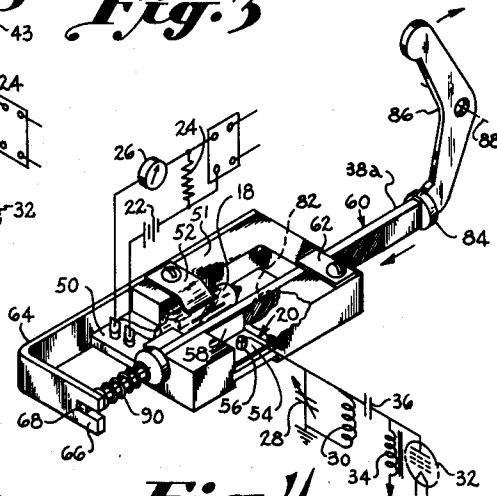


Fig. 4

Fig. 5b

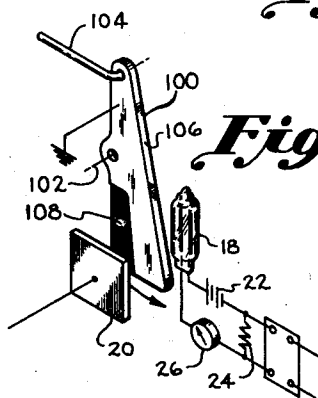


Fig. 6

Fig. 7

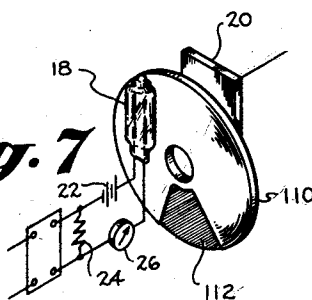
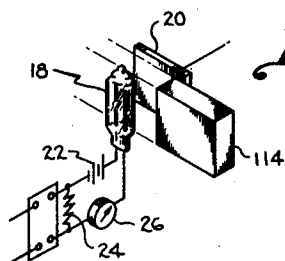


Fig. 8

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1

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SWITCHING SYSTEM FOR SELECTIVELY IONIZING GAS TUBES BY RADIO FREQUENCY ENERGY UNDER CONTROL OF MOVEABLE BLOCKING SHIELD

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This invention relates to electronic switching systems utilizing gas tube circuits and more particularly to circuits utilizing a tube in which the gas is ionized by means of externally applied radio frequency energy for controlling the starting and stopping of current conduction through the tube.

In electrically operated typewriters such as are used in keyboard type communications equipment that sets up, generates, and transmits coded or electrical impulse groups where each impulse group represents a character or letter, it has become necessary to provide for use in potentially explosive environments a switching arrangement which is free of arcing that is usually associated with switching contacts and which will provide trouble-free operation over a long period of time to reduce maintenance to a minimum. A two-electrode tube which is filled with an inert gas, such as neon, has long been known to be ionizable by radio frequency waves received through the tube envelope. Such tubes have been used to detect leakage of high frequency energy in hollow pipe waveguide installations and, as shown in U.S. Patent No. 2,658,142, used in high speed commutators by selectively ionizing the gas in and rendering conductive the tubes in a predetermined sequence.

A principal object of the present invention is to provide a novel switching method and system for use with an electrically operated typewriter keyboard.

Another object of the present invention is to provide a method for selectively energizing predetermined ones of a plurality of electronic circuits without utilizing any component which has make or break contacts or sliding brushes.

Still another object of the present invention is to provide a novel apparatus for effecting gas tube switching which includes reciprocating, oscillating and/or rotating vanes that serve as means for intermittently shielding and unshielding the gas tube from a source of radio frequency energy. Such vanes or shielding members may comprise a conductive material but preferably comprise a member composed of a conductive surface affixed to an insulating member with the conductive surface removed at predetermined positions on the member to provide a radio frequency energy window and thus permit momentary energization of the gas tube while normally keeping the tube blocked from conduction.

Other objects of the present invention will become more fully apparent from the claims, and from the description as it proceeds in connection with the appended drawings in which:

FIGURE 1 is an isometric view of one embodiment of the invention showing the gas tubes shielded and in the non-activated position in combination with a bar type plate energized with radio frequency energy;

FIGURE 2 is an isometric view showing one of the tube shields of FIGURE 1 removed to a position whereby the gas tube is unshielded;

FIGURE 3 is a pictorial view, partially broken away showing another embodiment of the invention utilizing a sliding vane type shield for use in a multiple tube switching system;

FIGURE 4 is a pictorial view of a further embodiment

2

of the invention showing a sliding vane type shield of different form;

FIGURES 5a and 5b are pictorial views of the sliding vane of FIGURE 4 shown in alternate reverse positions;

FIGURE 6 is a pictorial view of a further embodiment of the invention showing the vane shield as a swinging or oscillating member;

FIGURE 7 shows still a further embodiment of the invention, this time with a revolving disc type radio frequency interrupter; and

FIGURE 8 illustrates a somewhat different principle of operation capable of being used with radio frequency signals in both the VHF and UHF regions. In this embodiment, the solid dielectric gate acts as an energy transfer member instead of a shielding member.

Referring now to FIGURES 1 and 2, the invention will be described in connection with a keyboard type communications equipment, such for example as an electric typewriter having an actuating arm 10 mounted for pivotal movement about pin 12 through connection to the usual key lever (not shown) which may be made through link 11. Actuating arm 10, moving in a clockwise direction, pivots about pin 12 and pulls up on pull wire or rod 14, which is linked to a metallic sleeve 16.

Inside sleeve 16, a small tube 18 filled with neon or other suitable gas that may be ionized by radio frequency energy, is suitably mounted relative to a source of radio frequency energy as will be described below.

A bar or plate 20 is connected to a radio frequency tank circuit including capacitor 28 and inductor 30 and connected through capacitor 36 to a vacuum tube 32 which may be either a power amplifier or an oscillator. In either event, tube 32 serves as a source of radio frequency oscillations and in the embodiment illustrated serves as an amplifier having its plate voltage fed through choke coil 34.

Hollow sleeve 16 is grounded and therefore serves as a shield for the RF energy radiating from plate 20 to prevent ionization of the gas in tube 18. When sleeve 16 is raised, as by means of pull wire 14 and actuating arm 10, the high frequency radiation from bar 20 causes ionization of the gas in tube 18.

The control circuit connected to the terminals of tube 18 includes a source of D.C. voltage 22, which may be a battery, and a load resistor 24. The magnitude of voltage must be relatively low to prevent ionization of the gas in tube 18 resulting from the voltage gradient between the two electrodes inside tube 18. It is further contemplated that the voltage from source 22 will be pulsed in a conventional manner or otherwise of such small magnitude as to assure de-ionization of the gas once the tube envelope is effectively shielded from radio frequency energy. Indicating instrument 26 may be provided for observation of current flow, but it is not essential to the operation of the invention.

In operation, when tube shield 16 is in the position illustrated in FIGURE 1 covering tube 18 and preventing the radiated RF energy from causing ionization of the gas therein, tube 18 serves as a high impedance which prevents any substantial current flow through resistor 24 thereby resulting in a zero voltage drop across the terminals thereof. When shield 16 is raised so that tube 18 is exposed to the high frequency energy radiating from plate 20 as illustrated in FIGURE 2, the gas in tube 18 is ionized and it then offers a low resistance path to current flow from battery 22 through load resistor 24 thereby resulting in a current flow and a voltage drop across resistor 24. This voltage drop is then utilized in network 27 of the keyboard controlled communication equipment for generating, setting up and transmitting coded or electrical impulse groups in a well-known manner. By

the present invention, the conventional open contact type switch has been obviated from the equipment.

In the embodiment illustrated in FIGURE 1, a number of tubes corresponding to the number of keys on the typewriter is provided adjacent one or more bars 20 to be energized with radio frequency energy. The selective removal of shields 16 from the various ones of tubes 18 results in the coded information being set up in the communication system. When shield 16 is dropped back to surround tube 18, the voltage supplied by auxiliary source 22 is insufficient to keep the gas in tube 18 ionized whereby conduction in the tube abruptly halts.

The shielding device for tube 18 may take a large variety of forms and the method of the present invention may be used for many other purposes as will be apparent from the several modifications discussed below.

In the embodiment shown in FIGURE 3, gas tubes 18a, 18b and 18c are shown in a staggered positional relationship to be separated from each other by separate shielding devices 44.

Each of vanes 38a, 38b and 38c is mounted in suitable guides (not shown) for sliding motion in the direction of the arrows to cause compression or expansion of springs 42. A fixed frame member 43 is provided to receive one end of springs 42. Vanes 38 contain an RF window 44 which may comprise either an open or cut-out section, or a solid dielectric material which passes RF energy more efficiently than an air gap, depending upon its dielectric constant.

Radio frequency energy is supplied from vacuum tube 32 through capacitor 36 to a tank circuit including capacitor 28 and inductance 30 to radiation plates 20a and 20b. Plates 20a and 20b consist of a central body of dielectric material having opposite surfaces covered with metallic laminations. The RF energy is connected to be emitted from the metallic lamination only on the side of plates 20a and 20b which is visible. The edges of the metallic lamination on the side which radiates RF energy are partly milled off. The reverse side (not shown) is a solid metallic layer which is not connected to the tank circuit and hence serves to block any RF energy that may leak through the back side to inadvertently ionize tube 18c.

Levers 40a, 40b and 40c are mounted for pivotal movement about the axis of pin 41 and adapted to be actuated in any suitable manner by typewriter keys (not shown) to permit the corresponding ones of vanes 38a, 38b, and 38c to slide in a direction urged by compression springs 42, and to a position where windows 44 will be in alignment with gas tubes 18 to thereby permit the radio frequency energy from radiating plates 20a and 20b to pass through windows 44 to gas tubes 18a, 18b or 18c. After the typewriter key has been released, the corresponding vane 38 is driven back against the tension of spring 42 to be in the position for subsequent selection.

Separate utilization circuits are connected to each of tubes 18a, 18b and 18c to be used in selectively establishing the communication or utilization circuits.

Referring now to FIGURES 4 and 5, a further embodiment of the present invention is illustrated wherein gas tube 18 is supported on base 50 of a suitable insulating material. Clip 52 is provided on a side edge 51 of base 50 to secure tube 18 in a fixed position adjacent antenna plate 20. Antenna plate 20 in this embodiment is preferably formed of two angularly related legs 54 and 58 and is secured to base 50 as by terminal 56 so that leg 58 serves as a radiating member facing tube 18. Terminal 56 is connected to the tank circuit of the radio frequency tube 32.

Opposite end walls on base 50 contain rectangular grooves for receiving sliding vane 60, shown also in FIGURES 5a and 5b, and cover plate 62 serves to retain vane 60 in its slidable position on base 50. Bracket 64 is secured to base 50 and contains a bifurcated section 66 through which the small end 68 of vane 60 is slidable.

FIGURES 5a and 5b are perspective views of the same vane 60 shown in reversed positions. Between the main

body 70 of vane 60 and the reduced end 68, an abutment flange 72 is provided. Main body 70 is preferably formed of a laminated material containing a rigid dielectric member with a metallic lamination 76 on one side. The metallic lamination 76 is cut away to provide a window 82 which passes radio frequency energy. The metallic lamination 76 also provides a good grounding surface through contact with associated parts such as cover plate 62. Abutment member 84 is provided at the other end of vane 60 to receive one end of lever 86 which is mounted for pivotal movement about axis 88.

When lever 86 is in the position illustrated, tube 18 is shielded from the radio frequency energy on antenna plate 58 by the conductive lamination 76 on vane 60. When lever 86 pivots about axis 88 in a clockwise direction, vane 60 is moved against the tension of spring 90 until RF window 82 is positioned between antenna plate 58 and gas tube 18 at which time the gas in tube 18 ionizes and current then passes through the circuit including battery 22, gas tube 18, meter 26 and load resistor 24. When the force on lever 86 is removed, spring 90 causes vane 60 to move back to the normal position which shields tube 18 from the ionizing radio frequency energy.

In FIGURE 6, a further embodiment of the present invention is shown wherein tube 18 is separated from RF radiating plate 20 by vane 100 which is mounted for oscillating movement about axis 102. The position of vane 100 is controlled by rigid link 104. The portion of vane 100 which is between tube 18 and radiating plate 20 contains a first solid section comprising conductive material 106 and a radio frequency energy window 108 which may be either a cut-out or notched section or alternatively a dielectric member. As vane 100 swings to and fro, there results an intermittent breaking of the radio frequency energy radiated by plate 20 which reaches tube 18 to thereby intermittently energize tube 18 in such manner as to provide a square wave output across the terminals of load resistor 24. The repetition rate of such pulses depends upon the frequency of the to-and-fro movement of link 104 and the width of the pulse may be controlled by varying the size of window 108.

In FIGURE 7 a still further embodiment of the present invention is shown wherein radiating plate 20 is separated from gas tube 18 by a rotating vane 110. Vane 110 is preferably made from a laminated printed circuit board or equivalent and has a thin layer of copper laminated to one side of which a portion has been milled off to provide a window 112 of dielectric material through which RF energy can pass. The dielectric material is preferred for radio frequency energy since it serves as a better transmission medium than air. This particular type of construction may also be used for the vanes in the embodiments shown in FIGURES 3, 4, 5 and 6. As vane 110 rotates, the radio frequency energy from plate 20 is intermittently blocked and unblocked from gas tube 18 to serve as a means for producing the voltage pulses. The repetition rate of the pulses is determined by the number of revolutions per unit of time of vane 110 while the width of the pulses may be varied by varying the relative size of window 112 in comparison to the diameter of the vane which shields tube 18 from receiving radio frequency energy.

In FIGURE 8 a modified type of vane is illustrated for insertion between radiating plate 20 and gas tube 18. In this embodiment, sufficiently high frequency energy is used whereby solid dielectric vane 114 serves not as a shielding member, but as a dielectric energy transfer member. In this embodiment the power supplied to antenna 20 is insufficient to cause ionization of the gas in tube 18 when vane 114 is in its illustrated position. When vane 114 is moved to the region between plate 20 and tube 18, it serves to enhance the energy transfer so that tube 18 then becomes conductive. Thus in this embodiment, tube 18 is shielded when vane 114 is in its illustrated position out of the path of the energy between antenna 20 and tube 18.

5

By the present invention there is provided a novel contactless switching circuit arrangement which is especially well adapted for use around explosive or inflammable environments and which is free of the usual maintenance requirements of switching equipment having the usual switching contacts.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. Apparatus for selectively energizing predetermined ones of a plurality of electronic circuits each containing a cold cathode gaseous glow discharge tube having a dielectric envelope comprising means for energizing a plurality of said tubes with an operating potential insufficient to maintain ionization of the gas therein; means for continuously providing a radio frequency radiating field which is totally independent of said operating potential adjacent the envelope of said plurality of tubes which in combination with said operating potential is sufficient to cause ionization of the gas in said tubes; means for normally shielding said tubes from said radio frequency field to prevent ionization of the gas in said tubes and for selectively unshielding said tubes to effect ionization of gas in unshielded ones of said tubes and energization of electronic circuits associated with the unshielded ones of said tubes.

2. In combination with a gas filled tube envelope having an operating voltage applied to electrodes therein, said voltage being insufficient to cause or maintain ionization of the gas in said tube and a load resistor connected electrically in series circuit relation with said electrodes and across which a voltage drop appears when the gas in said tube is ionized, a radiating member mounted adjacent said tube envelope and energized with radio frequency energy of a magnitude sufficient to cause and maintain ionization of the gas in said tube in conjunction with application of said operating voltage, and means for optionally shielding the gas in said tube from said radio frequency energy for selectively controlling the time of occurrence of said voltage drop across said resistor.

3. The combination as defined in claim 2 wherein said shielding means comprises a metallic member connected to ground.

4. The combination as defined in claim 2 wherein said shielding means comprises a member composed of a conducting material affixed to one surface of an insulating material.

5. The combination as defined in claim 2 wherein said shielding means comprises a dielectric member which is moved to a position between said tube and said radiating member to effect ionization of the gas in said tube and away from said position to effect de-ionization of the gas in said tube.

6. The combination as defined in claim 2 wherein said shielding means is mounted for reciprocating movement into a space between said tube and said radiating member and further includes mechanically operated means for effecting reciprocating movement of said metallic member.

7. The combination as defined in claim 6 wherein said shielding means comprises a cylindrical metallic member adapted to be placed in a position surrounding said tube for shielding the gas in said tube from radio frequency energy.

8. The combination as defined in claim 6 wherein said shielding means comprises an elongated vane mounted for axial movement, said vane having one portion formed

6

to pass radio frequency energy and another portion formed to shield said tube from said radio frequency energy.

9. The combination as defined in claim 8 wherein said vane is composed of laminations of conducting material on opposite sides of insulating material.

10. The combination as defined in claim 2 wherein said shielding means comprises a vane mounted for movement about a pivot axis, said vane having a first portion formed to pass radio frequency energy and another portion formed to shield said tube from said radio frequency energy, and means mounting said vane in a space between said tube and said radiating member.

11. The combination as defined in claim 10 wherein said vane is mounted for rotational movement.

12. The combination as defined in claim 10 wherein said vane is mounted for reciprocating movement.

13. In combination, a plurality of gas filled tube envelopes each having an operating voltage connected to electrodes therein, said voltage being insufficient to cause ionization of the gas in the tube and load resistors connected electrically in series with said electrodes and across which a voltage drop appears when the gas in an associated one of said tubes is ionized, radiating means mounted adjacent said tube envelope and energized with radio frequency energy of a magnitude sufficient to cause ionization of the gas in said tube in conjunction with application of said operating voltage, means for normally shielding said tubes from said radiating means, and means for optionally rendering ineffective the shielding means for selected ones of said tubes.

14. The combination as defined in claim 13 wherein said radiating means comprises a plate connected electrically to a circuit resonant at the frequency of said radio frequency energy, said plate rigidly mounted adjacent a plurality of said gas filled tubes and said shielding means an electrically conducting member connected electrically to ground.

15. Apparatus comprising a base; a gas filled tube mounted on said base and connected to a circuit energized by a source of voltage and containing a load resistor; a radiating member mounted on said base adjacent said tube and connected to a source of radio frequency energy; shielding means mounted on said base for optional movement between said tube and said radiating member; spring means for urging said shielding means to a first position which prevents the gas in said tube from becoming ionized; and means for moving said shielding means against the bias of said spring to cause ionization of the gas in said tube.

16. Apparatus as defined in claim 15 wherein said shielding means comprises a flat vane and further comprising side walls extending in an angularly disposed relation to a plane surface on said base, said side walls having slots for receiving said flat vane for axial sliding movement; bracket means extending from one end of said base; means mounting said spring means between said bracket means and vane; and said means for moving said shielding means comprising an abutment member mounted to contact an end of said vane at a side of said base opposite said one end.

17. In combination with a switching system containing a gas tube selectively ionized through exposure to a fixed source of radio frequency energy mounted adjacent said tube; a vane-like member composed of laminations of conductive material on opposite sides of a layer of insulation material, and means for mounting said vane-like member for movement in a space between said radio frequency energy source and said tube, said vane-like member having both metallic laminations removed at one position to provide a radio frequency window.

18. In a circuit for controlling the selective on-off switching of a utilization circuit: a source of operating voltage; a gas tube having a pair of electrodes which conduct current on when the gas is ionized; a load resistor; circuit means for connecting said voltage source, gas

tube electrodes and load resistor in series, the magnitude of said voltage source being insufficient to cause or maintain ionization of the gas in said tube; means for ionizing the gas in said tube comprising a source of radio frequency voltage which is totally independent from said source of operating voltage, and a radiating member positioned adjacent said tube and coupled to said radio frequency source; and means normally positioned between said radiating member and tube for shielding said tube from the radio frequency energy and selectively movable out of said position to thereby permit the radio frequency energy to ionize the gas in said tube.

19. Apparatus for translating mechanical displacement into an electrical impulse comprising: a tube envelope having a filling of an ionizable gas and a pair of electrodes; a source of direct current voltage connected to the electrodes, the magnitude of said voltage being insufficient to cause ionization of the gas in or current conduction through said tube; a source of radio frequency

energy; a radiating member positioned adjacent said tube envelope and coupled to said radio frequency source, said radio frequency energy being of sufficient magnitude to cause ionization of said gas in and current conduction through said tube; and means movable into and out of a position between said radiating member and said tube envelope to selectively control the start and stop of current conduction through said tube.

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