

Dec. 16, 1952

F. CHRISTENSEN
IMPULSE GENERATOR

2,622,136

Filed July 26, 1949

2 SHEETS—SHEET 1

Fig. 1.

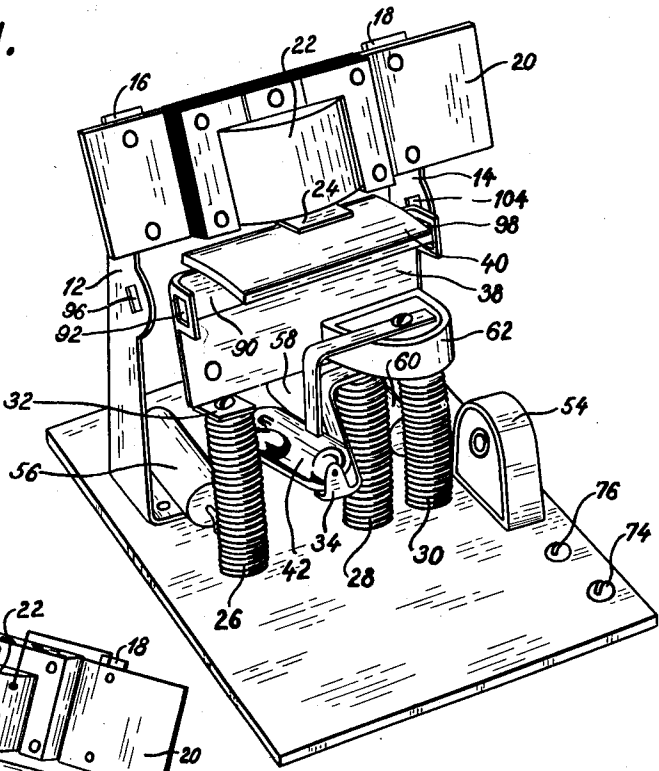
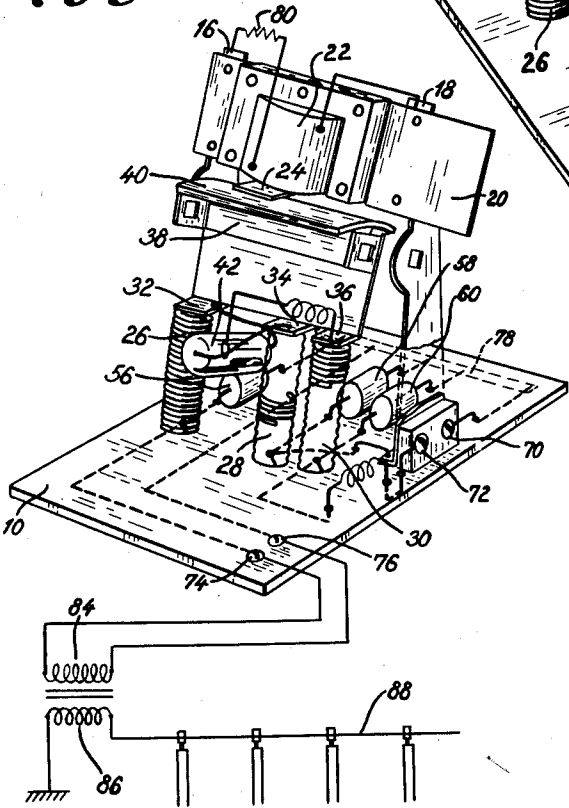


Fig. 2.



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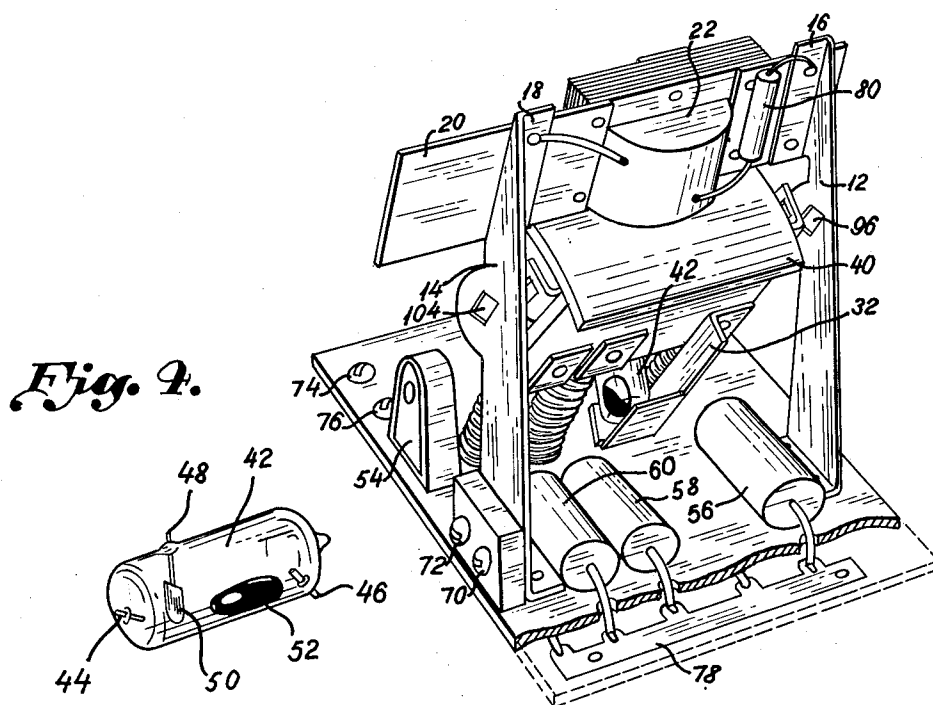
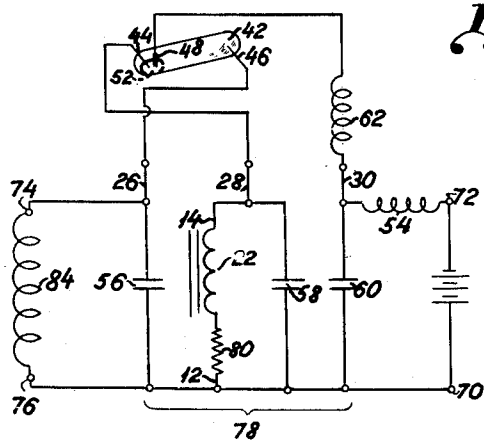
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2 SHEETS--SHEET 2

Fig. 3.



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UNITED STATES PATENT OFFICE

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IMPULSE GENERATOR

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In Denmark October 3, 1944

3 Claims. (Cl. 175-373)

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This is a continuation-in-part application of my prior application, Serial No. 617,995, now abandoned.

The present invention relates to an impulse mechanism.

One object of the invention is to provide an improved impulse mechanism for use in electric fence controllers.

Another object of the invention is to provide an improved impulse mechanism, which is simple and cheap in construction and reliable in operation.

A further object of the invention is to provide an impulse mechanism of the kind referred to, which is very robust and shock-proof.

Still another object of the invention is to provide an impulse mechanism of the kind referred to, in which there are no mechanical bearings, so that wear of such bearings is avoided, and thereby also failures in operation due to such bearings are avoided.

With these and other objects in mind, which will appear from the following description, the invention will now be described in detail with reference to the accompanying drawing, in which:

Figure 1 is a perspective view of the improved impulse mechanism, seen from one side,

Figure 2 is a perspective view seen from the other side,

Figure 3 is a perspective view seen from the opposite end of Figures 1 and 2,

Figure 4 is a perspective view of a mercury switch tube used in connection with the arrangement shown, seen in the same direction as it appears in Figure 2, and Figure 5 is a wiring diagram showing the switch circuit.

The impulse mechanism, which is now to be described in detail in the following, is especially designed to be used as an electric fence controller in the way diagrammatically shown.

From the following description of its operation it will be understood, however, that its use is not limited to this purpose, but that the impulse mechanism can be used in connection with other sorts of electric circuits, where impulses of short duration of regular intervals are utilized. Another use of the impulse mechanism is for instance in connection with traffic signals for instance in connection with level crossings, indicator lamps for road constructions and the like.

Referring now to the drawings, 10 is a base plate of insulating material. On the plate 10 are mounted two vertical arms 12 and 14 preferably of conducting material. These arms are secured to the base plate by means of screws, rivets or

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any other convenient manner. The upper ends of these arms marked 16 and 18 respectively are connected by means of a bridge 20 carrying an electromagnet 22 having an magnetic core producing at the under side an open magnetic field. To this purpose the core is preferably as indicated provided with three legs, which at the underside are not connected. As indicated one or a few of the plates, of which the core is built up, can be bent to form a projection 24, the purpose and effect of which will appear from the following.

On the base 10 are further arranged three upright helical springs marked 26, 28 and 30 respectively. The lower ends of these are secured to the base, for instance by means of screws. To the upper end of these springs are secured angle pieces 32, 34 and 36 having vertically bent parts mutually connected by means of an insulating plate 38.

On the top of the plate 38 is by means of screws, rivets or in another convenient manner secured a magnetic armature 40.

It will be understood that the mechanical arrangement here described will be able to oscillate like an inverted pendulum. The direction of the oscillation will be perpendicular to the plane thru the three springs 26, 28 and 30, which are arranged in one row parallel with the plane through the vertical arms 12 and 14 and the bridge 20.

The height of the oscillating part of the system is so adapted that a comparatively small air gap will be left between the under side of the magnetic core and the armature 40. The size of this air gap is not critical.

In the oscillating system is further arranged a mercury switch tube 42, the details of which are shown in Figure 4.

The mercury switch tube may, as shown, be carried by extensions of the angle pieces 32, 34 and 36, which simultaneously provide electrical connections to electrodes in the tube.

As shown in Figure 4 the tube 42 has three electrodes 44, 46 and 48. The switch tube is formed like a small cylinder. One electrode 44 is arranged substantially at one end wall extending into the interior like a small contact pin. The electrode 46 is arranged near the end wall, but at the border between the cylindrical part and the end extending into the tube from the bottom. The third electrode 48 is arranged nearer the electrode 44 extending into the tube from the top opposite the electrode 46. The electrode

48 is provided with a spadelike portion 50 terminating near the bottom of the tube. A volume of mercury 52 is arranged in the tube. The volume of the mercury and the distance between the electrodes is so mutually adapted, that the mercury in rest arranged as shown in Figure 4 between the electrodes 46 and 48 will not be able to make contact between these electrodes for the reason, that the surface tension of the mercury drop will prevent a horizontal extension of the drop, in which it can reach from contact 46 to contact 48.

The distance between the electrodes 44 and 48 should be so short that with the mercury in position between these two electrodes there is always electric connection between them.

Reverting now to the perspective views it will be understood that extensions of the three angle pieces 32, 34 and 36 can be soldered directly to the three electrodes to mount the mercury switch tube in the oscillating system. It will be understood, however, that the mercury switch tube can also be arranged in the oscillating system in other ways, for instance a supporting member, not shown, can be secured to the plate 38, and the electric connection between the electrodes and the mercury switch tube can be provided by means of wires having their other ends electrically connected with the top portions of the springs.

In the embodiment illustrated there is further arranged on the base plate 10 a choke coil 54 and three condensers 56, 58 and 60. A further choke coil 62 is arranged on the plate 38 in the oscillating system. The electric circuit of the arrangement, the mechanical parts of which are described herebefore, is the following (see Fig. 5):

70 and 72 are input terminals adapted to be connected with a convenient voltage supply, for instance a dry cell battery or any other supply means. 74 and 76 are output terminals of the system.

The terminal 72 is connected with one end of a choke coil 54. The other end of the choke coil 54 is connected with the lower end of the spring 30. The upper end of this spring is connected with one end of the choke coil 62. This connection is preferably made by means of a mounting screw or the like simultaneously carrying this coil. The other end of the choke coil 62 is connected with the electrode 48 of the mercury switch tube. The other input terminal 70 is connected with different parts. To facilitate the wiring, a common strip 78 of conducting material can be arranged under the base and connected with the input terminals 70. From this strip 78 direct leads are taken to one end of each of three condensers 56, 58 and 60, a further lead to the output terminal 76, and one more lead to the lower end of the vertical arm 12. The remaining electric connections are one lead from the electrode 44 and the mercury switch tube to top of the spring 28, one connection from bottom of spring 28 to bottom of other vertical arm 14, one connection from electrode 46 of mercury switch tube to top of spring 26 and a connection from bottom of spring 26 to output terminal 74.

The supply to the magnet 22 is taken thru two vertical arms 12 and 14. Between arm 12 and the magnet a resistance 80 is arranged.

It will be understood that the arms 12 and 14 do not need to be made of conducting material, and if found convenient can be moulded in one piece together with the base and the bridge plate 20. In such instance of course the wiring com-

prises leads extending up along the arms to connect the magnet coil with the other circuits.

As appears from the drawing the three springs are arranged in some distance from the two vertical arms 12 and 14. How far this distance should be will depend upon the extension of the armature 40 and the extension 24 of the magnetic core. The distance should be so, however, that in vertical position of the oscillating system comprising the springs and the armature, part of the armature is arranged under the extension 24. The upper part of the armature is curved as shown having its center arranged near the center of the mercury switch tube. This, in its turn, is arranged relatively low in the system, which has an advantageous effect on the energy consumption, as will appear from the following description of the operation.

The armature 40 is not symmetrically arranged, but has some overweight away from the magnet, which in connection with the weight of the choke coil 62 will tend to give the whole system a slight overweight away from the magnet, thereby causing the mercury in the mercury switch tube to take the position between the electrodes 44 and 48, thus establishing electrical connection between these two electrodes in the rest position of the oscillating system.

The arrangement described operates in the following manner:

When the voltage source is applied between the input terminals 70 and 72 with the parts in the rest position as described with a slight overweight of the oscillating system away from the magnet, and the mercury in the position between the electrodes 44 and 48 in the mercury switch tube, the first circuit established is a circuit through the choke coil 54, spring 30, choke coil 62, electrode 48, the mercury drop, electrode 44, top of spring 28 through spring 28 from the bottom thereof to bottom of arm 14, through arm 14, resistance 80, magnet 22, arm 12, strip 78 to the other input terminal.

Hereby the magnet is energized and by means of the magnetic field thus produced, the armature is attracted and the oscillating system tilted in clockwise direction seen in Figure 2.

Hereby the mercury is streaming from the left hand end of the switch tube to the right hand end.

Now the spade formed extension of the electrode 48 during this movement of the mercury operates to extend the mercury drop, acting like a wall attempting to prevent the mercury to change its position. Sufficient space is however, left between the bottom of the spade and the bottom of the tube to restrict this preventive action, so that the final result only is that the mercury drop is extended so that during its passage temporary contact is established between electrodes 48 and 46.

Simultaneously, however, the contact between electrodes 44 and 48 is broken, viz. the aforementioned circuit through the magnet coil is broken. Hereby the armature is no longer attracted by the magnet. The system will then continue its oscillation, until the counter action from the springs, which during the tilting movement have been bent, reach a value causing the movement to reverse. During the movement described, however, another circuit has been established, viz. in the short interval when the mercury connects the electrodes 48 and 46. This circuit established hereby comprises a circuit from the input terminal 72, choke coil 54, spring 30, choke coil 62

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over electrode 48 through mercury switch tube to electrode 46 and therefrom through spring 26 to output terminal 74. The other part of this circuit goes from input terminal 70 over strip 78 directly to output terminal 76.

By applying a load to the output terminals 74 and 76, the circuit will hereby be energized during the short interval, when the electrodes 48 and 46 are connected by means of the mercury. In case of using the arrangement described as an electric fence controller the primary winding 84 of a transformer will as indicated in Fig. 2 be connected to the output terminals, and the secondary winding 86 of the same transformer will then have one end connected to ground and the other end to a fence wire indicated as 88.

It will hereby be understood that in the short time interval described, a short impulse will be allowed to pass through the primary winding of the transformer, thereby causing a transformed impulse in the secondary winding and thus an impulse on to the fence. When the springs now take over the control of the movement tilting the system in the opposite direction, viz. anti-clockwise in Figure 2, the mercury in the mercury switch tube will, when the system passes the vertical position, again change its position and revert to the initial position, thus re-establishing the first described circuit through the magnet coil 22, which then again is energized, whereafter the cycle of operation starts over again.

The tension of the springs and the weight of the armature determine the oscillation period. It will be understood that the weight need not be included in the armature itself, but that any other weight can be used.

The three helical springs have their windings arranged in some distance for instance corresponding to the thickness of the thread used for the winding of the springs. The gauge of the spring wire will of course depend upon the rigidity wanted, and the oscillating period. A relation between the weight used and the gauge of the spring wire will however, easily be found by experiments to give a convenient oscillating period.

The unit described is utmost simple in construction, all parts being mounted with exception of the magnet coil and all circuit arrangements made on the base plate 10. The oscillating system moves like a reversed pendulum, or its movement can be compared with a metronome. The oscillating period can easily be adjusted to suit the purposes like electric fences, where a period of one, two or several seconds is necessary.

In contrast to previously known apparatus of similar kind, no mechanical bearings are used, and therefore no lubrication is necessary. All parts are entirely supported on the springs, and therefore the springs are the only parts, which can be subjected to wear. It has been found, however, by tests that the springs will be good for several millions of bendings forth and back without any indication of wear. This will correspond to more than 10 years' continuous operation without any service to this part of the construction.

As mentioned the mercury switch tube is arranged near the middle part of the springs. This gives a smaller movement of the tube and corresponding less consumption of energy, because the mercury drop, which changes its position two times during one whole oscillating period, will require less energy, when less force is applied to the mercury.

As indicated in the drawing there is below the

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armature arranged a part 90, which may be an integral part of the armature. At the ends of this part bent portions 92 and 94 are provided with openings 96 and 98. In the vertical arms corresponding openings 102 and 104 are provided. These openings serve the purpose of fixing the armature relatively to the rigid part of the construction for packaging and shipping purposes. This is merely done by putting in a pin through all four openings 96—102. A piece of wood will here be convenient.

In the foregoing description the effects of the three condensers and the two choke coils have not been mentioned. As appears from the description of the circuit arrangement the two choke coils are arranged in series in the circuit through the magnet coil or the consumer. One of the condensers is arranged between the connection of the two choke coils and the other input terminal, the other condenser is merely shunted over the magnet coil. The third condenser is inserted across the output terminals. The three condensers and the two choke coils hereby form a filter arrangement serving the purpose of suppressing harmonic oscillations to avoid disturbance of radio receivers from the operation of the impulse arrangement.

As mentioned the gauge of the spring wires will easily be found by experiments. In practice the springs should be relatively weak. The oscillating period of the system is proportional with the mass of the system divided with the rigidity. With a predetermined mass a low oscillation period can thus be obtained by a comparatively low rigidity. The rigidity of the spring system is a ratio between the force, trying to move the system back in the rest position, and the deflection angle from the rest position. In a deflective position the system is subjected to the difference between this force and an opposite directed force due to the gravity. This latter force can be regarded as a negative rigidity, because it acts in the opposite direction of the first mentioned force.

The difference between these two rigidities is the resulting rigidity of the system. It is this resulting rigidity, which has to be kept low to obtain a lower oscillation period. This again means that the difference between the rigidity of the spring system and the negative rigidity imposed by the gravity should be kept small compared with each of the two rigidities.

It will be understood that the embodiment shown in the drawings and described above is only an illustrated embodiment, which can be varied in different respects within the scope of my invention.

Thus, for instance it will be understood that the invention is not limited to the specific circuit arrangement shown and described.

The purpose of the mercury switch means is to control the opening and closing of the circuit arrangement. These switch means in their turn are controlled by the tilting movement of the inverted pendulum. In the embodiment shown a single mercury switch tube is used. Moreover, the electrodes in this tube are arranged in such a manner that the part of the circuit arrangement including the consumer apparatus is only closed, when the mercury in the tube passes from the left hand end seen in Figure 2 to the right hand end. In the opposite direction this circuit is not closed. Furthermore, the mercury switch tube and the whole circuit arrangement is made to switch on the electromagnet and the consumer

apparatus respectively by the tilting movement in opposite direction.

It will be understood, however, that the invention is not limited to the use of this specially described mercury switch tube, but that other mercury switch means can be carried by the pendulum within the scope of the invention. Such for instance two or more separate switch tubes can be arranged each controlling separate circuits.

Also the circuit arrangement can be varied within the scope of the invention. By using the device described as an electric fence controller for instance the main function is to produce short electric impulses with a certain time interval between each impulse. This can also be achieved by utilizing the changes in the magnetic field of the electromagnet driving the pendulum by means of a secondary step-up winding inductively coupled to the winding of the electromagnet. In such case the duration of the impulses sent thru the electromagnet must be sufficiently short.

Any such change of the mercury switch means and the circuit arrangement will, however, easily be made within the scope of the invention by those skilled in the art.

It will be appreciated that an important feature of my invention is that the springs supporting the inverted pendulum are included in the electric circuit arrangements in series with the mercury switch means. Hereby said springs form the electric connections to said mercury switch means. This gives an extreme simplification of the wiring, enabling all wiring to be made substantially under the base plate 10. Furthermore flexible leads are avoided, and thereby a source of faults is omitted. Such flexible leads will namely by repeated deflection have an ability to break. Moreover, they will mean a resistance against the oscillating movement. By the arrangement described the greatest possible simplicity is, however, obtained.

Having thus described my invention and the manner in which it operates, I claim:

1. In an electric fence control apparatus, in combination, a supporting structure, at least three relatively weak upright resilient members connected to said supporting structure, said resilient members being arranged to conduct electric current and composed of resilient material of predetermined rigidity, a weight supported uprightly by said resilient members and forming therewith an inverted pendulum oscillatable in opposite directions of the upright position between opposite extreme tilted positions and being in the extreme positions influenced by a gravitational force only slightly smaller than the force exercised by the rigidity of the resilient members urging the pendulum to return to its upright position, a magnetic armature connected to said inverted pendulum and movable therewith, an energizing magnet positioned adjacent the path of said armature and operable to produce a magnetic field acting on the armature to tilt the pendulum in one direction to one extreme position, a three terminal mercury switch mounted on said pendulum and tiltable therewith, two of said terminals being normally bridged by the mercury when said pendulum is near the opposite extreme normal position and the third terminal being disposed at a distance therefrom and arranged to be interconnected to one of said two terminals by the mercury when said pendulum is near the said one extreme position, and an electric circuit having input terminals and output terminals and comprising a magnet ener-

gizing branch circuit including one of said input terminals, one of said resilient members, said two mercury switch terminals, a second resilient member, said magnet, and a second input terminal, and an output impulsing branch circuit including said one input terminal, said first resilient member, said one of the two mercury switch terminals, said third mercury switch terminal, the third resilient member, and one of said output terminals, a second output terminal being interconnected to said second input terminal.

2. In an electric fence control apparatus, in combination: a supporting structure; resilient means supported by said structure and including at least three upright supporting springs being arranged to conduct electric current and having a predetermined relatively weak erecting force; a weight supported by said springs and forming therewith an inverted pendulum oscillatable in opposite directions of the upright position between opposite extreme positions of tilting, and being in the extreme pendulum positions influenced by a gravitational force only slightly smaller than the erecting force of said resilient means; a magnetic armature connected to said pendulum and movable therewith; an energizing magnet positioned adjacent the path of said armature and operable to be energized to produce a magnetic field acting on the armature to move the pendulum to one extreme position; a switch mounted on said pendulum and being tiltable therewith and including three separate electrodes whereof two are being spaced at a distance from the third and means movable relative to said electrodes and actuatable in said extreme positions for normally interconnecting said two electrodes when the pendulum is near the opposite extreme normal position and respectively for interconnecting one of said two electrodes with the third electrode when the pendulum is near said one extreme position; a circuit including input terminals and output terminals; and comprising a magnet energizing branch circuit including one of said input terminals and one of said springs and said two electrodes, a second spring and said magnet and a second input terminal and being operable to be closed in said opposite extreme position by said movable means interconnecting said two electrodes to energize said magnet; and an impulsing branch circuit including said one input terminal and said first spring and said one of the two electrodes, said third electrode, the third spring, and one of said output terminals, and another output terminal and the second input terminal being interconnected and being operable in said one extreme position by said movable means interconnecting said third electrode with said one of the two electrodes to deliver an impulse across said output terminals.

3. In an electric fence control apparatus, as claimed in claim 2, further characterized in that said switch includes an elongated enclosure for mercury, and said movable means is a mercury globule movable by gravity within said enclosure, said electrodes projecting through said enclosure and terminating on the interior thereof for contact with said globule, said two electrodes terminating near one end of said enclosure and the third electrode terminating near the other end thereof.

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