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D. ELLIS ET AL
SHOCKPROOF CONTACTOR

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2 Sheets-Sheet 1

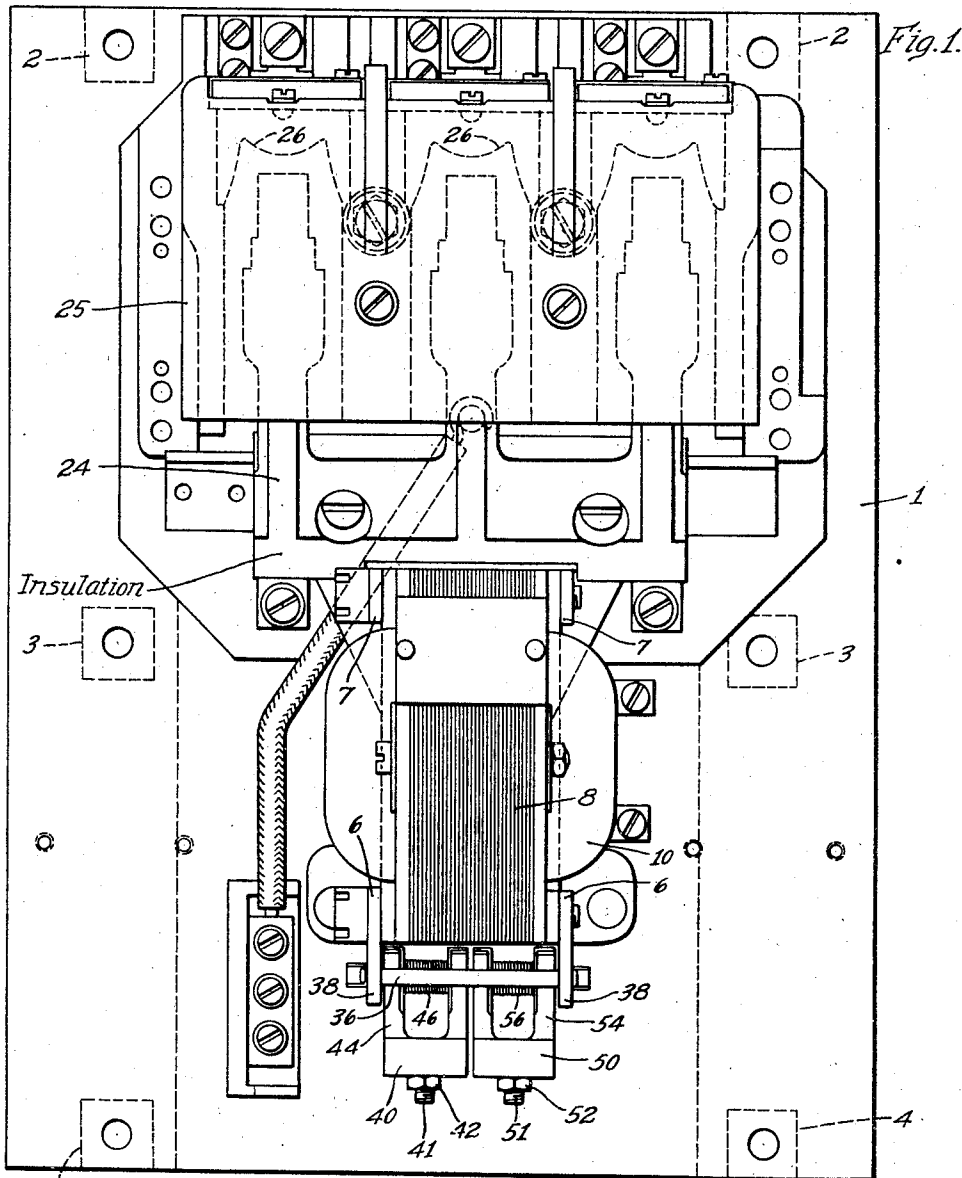
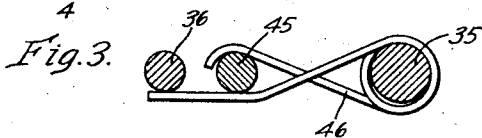
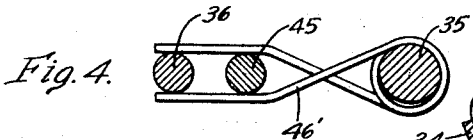
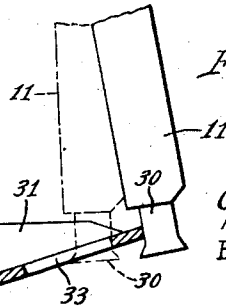


Fig. 6.

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Fig. 2.

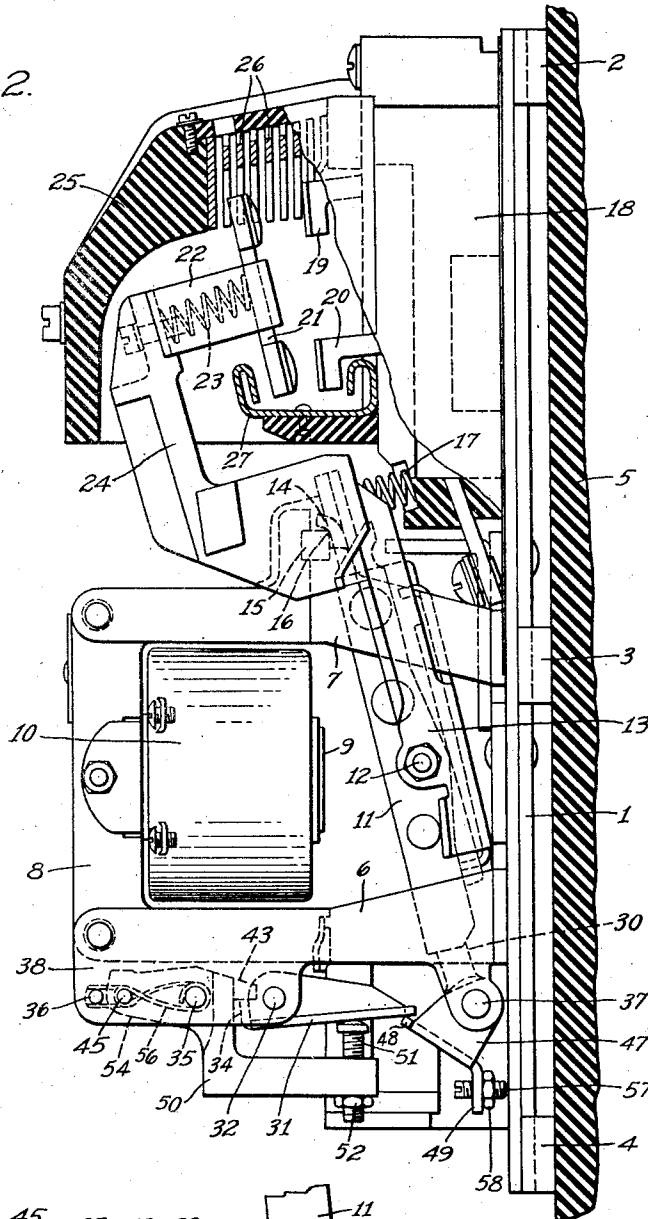
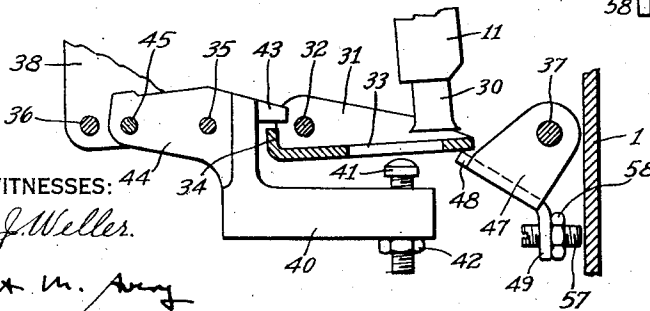


Fig. 5.



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SHOCKPROOF CONTACTOR

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Our invention relates to shock-responsive latching devices for preventing failure or faulty operation of electric apparatus, especially contactors, under impact or shock conditions.

It has been proposed to prevent electric relays and switches from uncontrolled operations when exposed to shock or vibrations by providing them with a latching device which, usually inoperative, is placed into latching condition by means of a mechanical vibratory system that responds more readily to shock than the apparatus to be protected and locks the apparatus in position as long as the shock or its vibratory effect persists.

A general object of our invention is to improve latching devices and shockproof apparatus of the type just mentioned so as to increase their range of response and render their adjustment less exacting than in the known devices.

The vibratory system in the known shock-responsive latching devices, usually composed of a movable weight and a spring, is rather critical as to the adjustment necessary for covering a satisfactory range of low and high impact forces. It may occur that a device which works satisfactorily on low impact forces responds to a lesser degree on high impact blows and vice versa. Such a device may also be exposed to impacts of a frequency too different from the natural frequency of the weight and spring combination to be sufficiently within the range covered by the damped resonance characteristic of the latching device. Hence, it is a more specific object of the invention to provide a latching device that responds more safely to shock of widely different magnitudes and frequencies.

Another specific object is to render one and the same shock-responsive locking device applicable for operation under different shock conditions without requiring an adjustment for the particular conditions to be dealt with.

A further object of the invention is directed toward facilitating the manufacture and assembly of this type of devices in the factory by eliminating the necessity of a correct calibration of frequency and damping to narrow test conditions.

A still further object of our invention is to provide a shock-responsive latching device for electric apparatus, especially electromagnetic contactors, that is distinguished by an increased speed of response to heavy shock forces and blows acting on the base or mounting plate of the apparatus so as to obtain, in exceptional cases, a latching operation more quickly than afforded

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by any of the inertia controlled latch mechanisms heretofore suggested.

In order to achieve these objects and in accordance with one aspect of our invention, the apparatus to be latched upon occurrence of shock has a normally inoperative latch provided with a plurality of mechanical oscillatory systems of different oscillation characteristics, which control the latch independently of one another so that the latch is moved into latching or locking position when any of the individual systems responds to shock.

According to another feature of the invention, we provide a device of the type just mentioned with a number of independently movable weights of substantially equal mass and dimensions and attach thereto a corresponding number of springs of different elasticity or stiffness so that the oscillators have different natural frequencies because of the different springs.

In another aspect of our invention, the movable latch member of a shock-responsive latching device is provided with a back stop which limits the motion of the latch member toward its normal, i. e., unlatched position and is pivotally mounted on the base structure of the apparatus. The back stop has an abutment resting against the base structure so that when heavy shocks are imparted to the structure, the back stop is flung toward the latching lever, thus forcing it quickly into latching position.

These objects and features will be fully understood from the following description of the embodiment illustrated in the drawings, in which:

Figure 1 is a front view of a shockproof contactor constructed in accordance with the present invention.

Fig. 2 is a view in side elevation, partly in section, of the same contactor.

Fig. 3 represents a detail of the same contactor, and Fig. 4 a somewhat modified form of the same detail.

Fig. 5 represents the shock-responsive latching mechanism of the contactor with its individual parts in the inoperative position, while

Fig. 6 is a similar but simplified representation of the latching elements proper showing them in two different operative positions.

The contactor illustrated in the drawings is of the line-starter type for connecting an electric motor or other load across the mains of a power supply line. As regards some details of this line starter which are incidental or of little relevance to the present invention proper, reference may be had to the copending application, Serial No.

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458,386, filed September 15, 1942, by Delbert Ellis and James H. Alspach, on Contactors. For certain other details of the illustrated embodiment, relating to contact and arc-quenching means not directly involved in the invention proper, recourse may also be had to the copending application, Serial No. 453,058, filed July 31, 1942, by Delbert Ellis and Owen L. Taylor, on Arc limiting devices, although the illustrated embodiment is fully and independently described hereinafter as to all features and details relating to the present invention.

Referring to Figs. 1 and 2 of the drawings, numeral 1 denotes a base plate which at 2, 3, and 4 is provided with means for mounting it on a suitable support 5, for instance, a wall or panel. Two pairs of standards 6 and 7 consisting of iron are firmly mounted on the base plate 1 and carry at their extremity a laminated magnet core 8 which forms a pole surface at 9 and carries a magnet coil 10.

The appertaining magnet armature 11, consisting also of a laminated magnetic body, is mounted at 12 on a channel-shaped member 13 so as to be capable of limited pivotal adjusting motions relative to the member 13. The member 13 has an extension 14 which rests against a pivot bar 15 of square cross-section. The pivot bar 15 is mounted on the pair of standards denoted by the numerals 7, so as to be prevented from revolving relative to the standards. One of the edges of the pivot bar 15 forms a pivot bearing at 16 of knife-edge type, and this pivot edge is engaged by an angular portion of the extension 14 of member 13. A helical compression spring 17 resting against a stationary abutment and engaging the member 13 biases this member and its extension 14 against the pivot edge. Consequently, the armature assembly including the elements 11, 12, 13, 14, and all other parts attached thereto and to be described presently are pivotally rotatable about the edge 16 and are normally held in the illustrated position by the force of the biasing spring 17.

The stationary abutment for the spring 17 is formed by an insulating body 18 which is firmly secured to the base plate 1 and carries three pairs of stationary contacts such as the pair of contacts denoted by 19 and 20 in Fig. 2. Each pair of stationary contacts cooperates with a movable contact bridge 21 which, according to Fig. 2, is movably arranged in a saddle 22 and under bias of a contact spring 23. The saddle 22 and the contact bridge 21 with its appertaining spring are mounted on an insulating holder 24 which connects the three movable contact assemblies with the channel member 13. Due to the above-mentioned action of the biasing spring 17, the contacts are kept in the illustrated open position as long as the magnetic coil 10 remains deenergized. Upon energization of the coil 10, the armature 11 is pulled towards the magnet pole 9 and moves the contact assembly into the contact closing position.

The contact gaps between bridge 21 and stationary contacts 19 and 20 are located within arcing chambers or boxes formed by an insulating body 25. Each arc box is provided with a set of deionizing grids 26 arranged in proximity to the stationary contact 19 and the appertaining contact of bridge 21 in order to subdivide and quench the arc occurring at this interrupting gap. A substantially U-shaped structure 27 of magnetizable metal is arranged in proximity to the stationary contact 20, and the appertaining contact

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of bridge 21 for promoting the extension of any arc occurring along this interrupting gap. The operation of these arc-quenching means is not essential to the invention proper so that a further description of these details appears unnecessary, especially in view of the availability of the more detailed disclosure in the above-mentioned copending application on Arc-limiting devices.

A latch member 30 is rigidly mounted on the armature 11 for cooperation with a shock-responsive latching mechanism which will be described hereinafter with reference to Figs. 1 through 6 of the drawings.

As is best apparent from Figs. 2 and 5, a latch lever 31 of substantially U-shaped cross-section is mounted on a shaft 32 which, in turn, is secured between portions 38 of the two standards 6, respectively. The lever 31 has an opening at 33 and forms a projection or abutment at 34 (Fig. 5). Another shaft 35 extending in parallel to shaft 32 between the portions 38 of the two standards 6 serves as a fulcrum for two weights denoted by 40 and 50, respectively (Figs. 1, 2, and 5). Each of these weights carries at one of its extremities a screw 51 which is threaded through the body of the weight and secured in proper position by means of a nut 42. The head of this screw 41 is located in proximity to the latching lever 31 so that when the weight moves in counterclockwise direction, the head of screw 41 engages the lever 31 and turns it in the upward direction. The weight 40 has a rigid projection 43 so located as to engage the abutment 34 of the lever 33 when the weight moves about shaft 35 in the clockwise direction. The latter engagement has also the effect of turning the latching lever 31 in the upward direction. When the weight 40 performs oscillations about its fulcrum, the two elements 41 and 43 will alternately engage the latch lever and hence will maintain it in raised position. When the weight 40 is inoperative, the lever 31 follows the bias of its gravity and turns into the illustrated downward position.

The weight 50 (Fig. 2) is also provided with a screw 51 and locking nut 52 and has also a projection corresponding to the element 43 of lever 40. Weight 50 is fulcrumed about the same shaft 35, and hence when oscillating moves in parallel to weight 40, operating in the same manner on the same latching lever 31.

The portion 44 of weight 40, according to Fig. 5, carries a pin 45 in proximity to a stationary pin 36 which extends between the portions 38 of the two standards 6, respectively. A spring wire 46 is wound about shaft 35 and engages the pins 45 and 36 in the manner illustrated in Fig. 3. According to the modification in Fig. 4, a wire spring 46' having a somewhat different engagement with the two pins 45 and 36 may also be employed. In both modifications of Figs. 3 and 4, the spring tends to maintain the appertaining weight 40 in the inoperative position shown in Fig. 5. The spring and the weight form together an oscillatory system.

The weight 50 (Fig. 1) is also provided with a spring 56 which is arranged similar to the just-mentioned spring 46 or 46' of weight 40, and hence forms together with weight 50 a second oscillatory system. The oscillation characteristics of the two systems are different from each other as regards their natural frequencies as will be set forth more in detail in a later place.

As mentioned previously, the latching lever 31 due to its gravity has the tendency to turn away from the latch 30. This motion is limited by a

back stop 48 which forms part of a stop member 47. This member is pivoted about a pin 37 which extends between the two standards 6 in parallel to the pivot axis of the armature assembly. Another part 49 of stop member 47 carries an adjusting screw 57 which is firmly secured in proper position by means of a nut 58. The stop member 47 tends to maintain the position illustrated in Figs. 2 and 5 where the screw 57 rests against the surface of the base plate 1.

The operation of the latching means described in the foregoing is as follows: When the contactor is mounted in the vertical position, as shown in Fig. 2, and its support or mounting panel not subjected to shock or vibration, the two weights 40 and 50 are kept by their respective springs in the inoperative position corresponding to Fig. 5, and the latch lever 31 rests against the back stop 48, while the stop member 47, as shown, has its screw 57 abut against the surface of the base plate 1. In this position, the latch lever 31 is so spaced from the latch 30 of the armature 11 that it does not interfere with the operation of the armature. Consequently, as long as the above-assumed conditions persist, the contactor can be operated by energizing and de-energizing its magnet coil 10 in the customary manner. When the support of the contactor is exposed to high impact shock as occurring, for instance, on naval vessels due to collision or the operation of internal equipment, the shock motion of the support may be transmitted to the base plate 1 and the parts of the contactor mounted thereon. It is desired that the contact position of the contactor remain unaffected by such forces. That is, when the electric contacts are opened immediately previous to the occurrence of shock, they are supposed to stay open, and when the contacts are closed, they should stay closed during the occurrence and persistence of shock forces. It will be shown presently that the above-described latching means will lock the armature assembly in either of its contact closing or opening positions in accordance with the just-mentioned requirements.

When a shock occurs so as to be transmitted by the base plate to the movable parts of the contactor, the armature assembly may have the tendency to perform uncontrolled pivotal motions. These motions have a relatively high natural frequency due to the relatively great stiffness of the spring 17 appertaining to the armature assembly. The same shock forces will act on the two oscillatory systems represented by the weights 40 and 50 and their appertaining springs. These weights follow more quickly the effect of an impact by performing a motion relative to the standards or magnet frame on which they are fulcrumed. That is, the springs of these two systems are very soft as compared to the armature spring 17 so that the two weights 40 and 50 may be considered as having the tendency to maintain their original position in space due to their inertia. The relative motion between each weight and the standards thus produced has the effect of moving the latch lever 31 into latching position. Assuming that the armature assembly was in the contact opening position at the time of shock transmission, its position is represented by the solid line illustration of element 11 in Fig. 6. When the latch lever 31, as just explained, is moved into its operative position, it will reach this position before the armature assembly can perform an appreciable angular motion. Hence, the latch 30 of armature

11 is now stopped by the end of lever 31 from moving into the contact closing position. On the other hand, if the contacts were open at the occurrence of shock, the latch lever 31 when moving into its operative position will catch with its opening 33 over the latch 30 as is represented in Fig. 6 by the broken line illustration. Hence, the armature assembly is now prevented from performing an uncontrolled opening motion.

It has been mentioned that the two oscillating systems involving the weights 40 and 50 are of different oscillatory characteristics. For instance, the two weights may be of substantially equal mass while the appertaining springs have different stiffness. Such a difference would have the effect of rendering the natural frequency of the two systems slightly different. A similar effect can be obtained by using similar springs but providing two weights of different mass.

Due to the difference in natural frequency, the two systems oscillate usually out of phase. As a result, the moments of engagement between each weight and the latch lever occur in between periods as regards the moments of engagement of the other weight. Consequently, the latch lever is more steadily kept in the latching position and maintains an increased amplitude of latching motion. A further advantage of the just-mentioned difference in frequency is that one system will react to lower vibration frequencies than the other. Consequently, the total range of shock frequencies to which the device will respond can be increased over the shock-responsive locking devices heretofore suggested having but a single oscillatory system.

There are cases of extremely heavy impact shocks where the shock forces transmitted through the support to the base plate of the contactor are so intense and immediate that the armature assembly may be caused to move a noticeable extent before the oscillatory systems of the latching device are sufficiently effective. In order to cope with such extreme conditions, the above-described stop member 47 is provided. Since this member is movable relative to the base plate 1 in a direction toward and away from the plate, any shock force acting in this direction, or having an unduly large component in this direction, will have the effect of flinging the screw 57 away from the plate 1 (Fig. 5). Since the connection usually formed by the stop member 47 between the plate 1 and the latch lever 31 is rigid, the just-mentioned motion is directly transmitted to the lever 31 with the effect of turning the lever 31 in the upward direction, thereby initiating and anticipating the subsequent locking action of the oscillatory weights. In consequence, the desired latching action in case of the last-mentioned extreme shock conditions is speeded up to such an extent as to provide the desired safety of operation.

A contactor of the above-described type, if provided with customary interlock or holding contacts actuated by the armature to close a holding or self-sealing circuit for the contactor coil 10, can be exposed to impact shocks of extreme intensity without opening the circuit at contacts 19, 20 and 21 even if the shock forces are strong enough to temporarily lift the contacts, including the holding contacts. That is, if in the latched closed position of the contactor the holding contacts should be forced to open the coil circuit, the latching device will hold the armature locked and hence cause the con-

tacts to immediately reestablish the coil circuit thus maintaining the closed position of the contactor.

It will be understood that devices according to our invention can be modified in various ways without departing from the essential features of the invention. For instance, in order to secure a proper bias of the latching lever or of the movable back stop member, or both, in any position of the contactor, additional biasing springs may be provided so that the operation becomes independent of the biasing effect of gravity. It will also be apparent to those skilled in the art upon study of the present disclosure that the latching means may be altered as to their shape and arrangement without affecting the gist of this invention. In view of such possibilities, we wish this specification to be understood as illustrative rather than in a limiting sense.

We claim as our invention:

1. An electric apparatus comprising, in combination, a base plate for mounting the apparatus, an operating member mounted on said plate for motion between two positions, a movable latch arranged for locking said member in either of said positions and normally biased for motion in unlocking direction, and a stop member arranged for limiting the unlatching motion of said latch and movably mounted for motion toward and away from said base plate, said stop member having a portion normally resting against said plate so that said stop member is flung toward said latch in order to move it into latching position when said plate is subjected to high impact shock in the moving direction of said stop member.

2. An electric apparatus comprising, in combination, a base plate for mounting the apparatus, an operating member mounted on said plate for motion between two positions, a movable latch arranged for locking said member in either of said positions and normally biased for motion in unlocking direction, and a stop member arranged for limiting the unlatching motion of said latch and pivotally mounted in proximity to said base plate for angular motion toward and away from said plate, said stop member having a portion normally resting against said plate so that said stop member is flung towards said latch in order to move it into latching position when said plate is subjected to high impact shock in the moving direction of said stop member.

3. An electric apparatus comprising, in combination, a base, an operating member mounted on said base for motion between two end positions, a movable latch arranged for locking said member in either of said positions and having a bias towards the inoperative latch position, a shock responsive oscillatory device for moving said latch against its bias into operative position upon the occurrence of shock, and a movable stop member pivoted to said base for motion towards and away from said base, said stop member having a portion in proximity to said latch and another position in proximity to said base so as to transmit shock motion directly from said base to said latch in order to initiate the locking operation of said latch when said base is subjected to high impact shock in the moving direction of said stop member.

4. An electric apparatus comprising, in combination, a mounting base, an operating assembly movable relative to said base between two positions, a latch member attached to said assembly, a normally inoperative latching lever for engaging, when operative, said latch member so as to lock said assembly in either of said positions, inertia controlled oscillatory means arranged for engaging said lever so as to move it into its operative position upon occurrence of shock, and a rigid body movably arranged between said base and said lever so as to be normally in contact with said base for a direct transmission of shock motion from said base to said lever in order to render said lever operative previous to said oscillations upon occurrence of given shock conditions.

5. A shock-responsive latching device, comprising a support, a latch movably mounted on said support and having a bias toward unlatching position, a plurality of vibratory mechanical systems each having a movable weight and a spring and being secured to said support separately from said latch, said systems having different oscillatory characteristics so as to vibrate out of phase relative to one another when subjected to shock and being arranged to separately engage said latch so that each system is capable of holding said latch in latching position against the latch bias and during in-between periods as regards the latch holding performance of another one of said systems.

6. A shock-responsive latching device, comprising a support, a latch movably mounted on said support and having a bias toward unlatching position, a plurality of oscillatory systems arranged for individually moving said latch into latching position in response to shock and having each a weight and a spring, said weights having substantially equal mass and being movably mounted on said support in parallel to one another, and said springs having different stiffness to provide different oscillation characteristics for said systems so that said systems oscillate out of phase relative to one another when subjected to shock, whereby each system is capable of holding said latch in latching position against the latch bias and during in-between periods as regards the latch holding performance of another one of said systems.

7. An electric apparatus comprising an operating assembly movable between two positions, a support, latch means movably secured to said support for locking said assembly in either of said positions and having a bias toward unlatching position, and a plurality of oscillatory systems arranged for individually engaging said latch means and having each a weight movably mounted so as to be capable of individual oscillation for moving said latch means into latching position during occurrence of shock, said systems having different oscillatory characteristics to oscillate out of phase relative to one another so that each system is capable of holding said latch means in latching position against said bias and during in-between periods as regards the latching performance of another one of said systems.

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