Aug. 29, 1950 T. B. JOCHEM 2,520,212

TIME DELAY RELAY

Filed June 3, 1948 2 Sheets-Sheet 1

Fig. 1

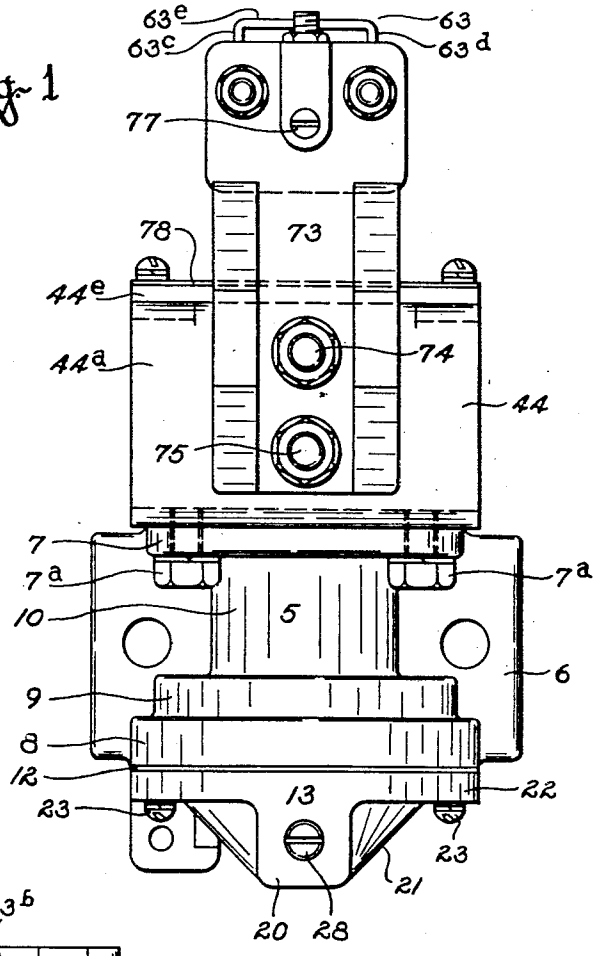
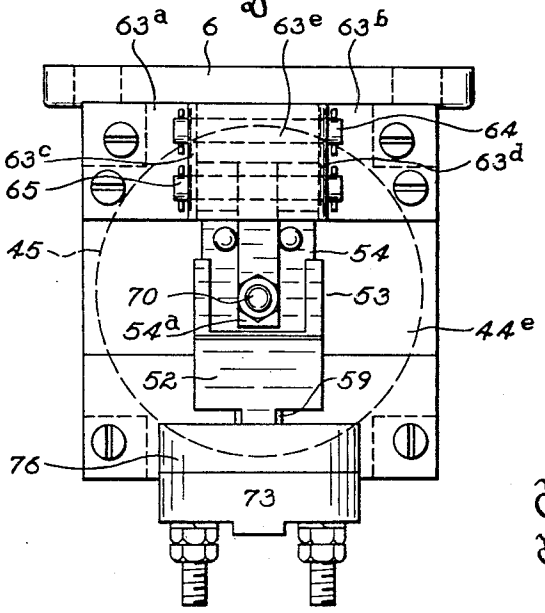


Fig. 2



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TIME DELAY RELAY

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Fig. 3

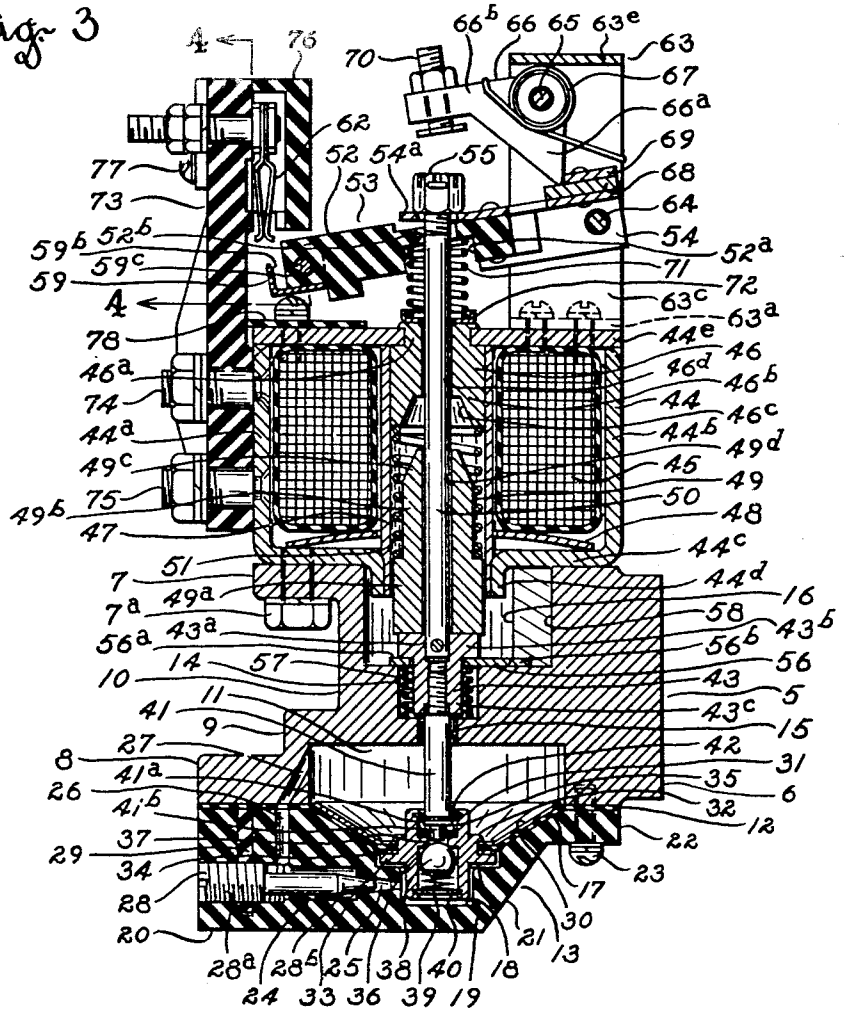
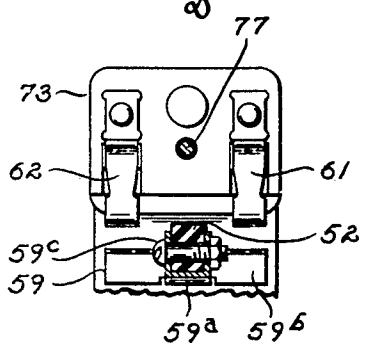


Fig. 4



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Patented Aug. 29, 1950

2,520,212

UNITED STATES PATENT OFFICE

2,520,212

TIME-DELAY RELAY

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Application June 3, 1948, Serial No. 30,952

9 Claims. (Cl. 200—97)

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This invention relates to electromagnetically operated relays of the time delay type.

A primary object of the invention is to provide an electromagnetically operated relay having time delay means which is capable of withstanding high intensity shocks such as are met with on naval ships under war time service conditions without unwanted changes from selected operating conditions.

Another object is to provide a relay of the aforementioned type which is characterized by quick make and break operation of its contacts for direct current service at relatively high voltages.

Another object is to provide a relay of the aforementioned type using a minimum number of moving parts to effect the desired sequence and character of operation.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate one embodiment of the invention which will now be described, it being understood that the embodiment illustrated is susceptible of various modifications in respect of its details without departing from the scope of the appended claims.

In the drawings:

Figure 1 is a front elevational view of an electromagnetically operated relay constructed in accordance with the invention.

Fig. 2 is a top plan view of the relay in Fig. 1.

Fig. 3 is a sectional view in side elevation of the relay in Fig. 1, and

Fig. 4 is a view taken substantially along the broken line 4—4 of Fig. 3.

Referring to Figs. 1 to 3, inclusive, they show a preferred form of support and housing member 5 which provides for the support and mounting of the various parts of the relay assembly. Member 5, which is preferably a molded casting of brass or other non-magnetic metal, comprises a vertical bracket portion 6, an upper flanged base portion 7 and a lower flanged base portion 8 integrally connected by concentric portions 9 and 10 which are substantially cylindrical in form. The base portions 7 and 8 are each substantially rectangular in horizontal cross section and the bracket portion 6 is rectangular in vertical cross section. The bracket portion 6 is provided with openings extending therethrough to facilitate mounting of the relay assembly. A downwardly opening cylindrical recess 11 (Fig. 3) is formed in member 5 within the portions 8 and 9 and provides a chamber adapted to accommodate a flexible diaphragm 12 upon upward movement of the latter, said diaphragm being secured between the base portion 8 and a bottom cover member 13. An upwardly opening chamber is provided within the portions 7, 9 and 10 of member 5, said chamber comprising a cylindrical recess 14 which at its lower end communicates with the recess 11 through a passage 15, and a concentric cylindrical recess 16 of larger diameter opening through the base portion 7 of member 5 at its upper end and communicating at its lower end with the recess 14.

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Cover member 13 which is preferably molded from a suitable phenolic molding compound is provided with an upwardly opening chamber to accommodate diaphragm 12 upon downward movement of the latter. This chamber has an upper portion 17 of inverted frusto-conical form and has concentric therewith a shallow cylindrical portion 18 of relatively large diameter and a deeper portion 19 of smaller diameter. Member 13 is also provided at its lower end with an integral portion 20 of substantially rectangular form in vertical cross section, said portion 20 merging into a frusto-conical portion 21 which underlies the afore-described chamber. Portion 21 has a flange 22 abutting the base portion 8 of member 5 to which it is secured at spaced points by screws 23. Portion 20 of member 13 has exteriorly opening cylindrical passage 24 which extends lengthwise thereof and which leads to the large end of a tapered passage 25 communicating with the cylindrical portion 19 of said chamber. A cylindrical passage 26 of small diameter extends upwardly from passage 24 and communicates with a passage 27 formed in member 5 and leading to recess 11.

Passage 24 is suitably threaded from its outer end for a portion of its length for cooperation with a threaded end portion 28^a of an adjustable needle valve screw 28. Needle valve screw 28 is thus adapted to be adjusted longitudinally within passage 24 so that its tapered end portion 28^b which is axially alined with the tapered passage 25 may be projected into or withdrawn from passage 25 to close or open the latter to the desired degree. Member 13 has formed therein transversely of the passage 24 a substantially rectangular upwardly opening slot to receive a fiber member 29 which frictionally accommodates the threaded portion 28^a of valve screw 28 and which tends to lock the latter when adjusted to any position.

The flexible diaphragm 12 is preferably made in circular form from a thin sheet of rubber impregnated textile material. It is provided with

a series of marginal openings to register with screw receiving openings formed in the flange portion 22 of member 13 and is also provided with an opening registering with the passage 26 of member 13 and the passage 27 in member 5. Extending through diaphragm 12 centrally thereof and suitably clamped thereto is an assembly comprising a disc 30 of substantially inverted frusto-conical form overlying the diaphragm, and a relief valve 31. Diaphragm 12 is of greater diameter than disc 30 and is secured about its outer circumference between the portion 8 of member 5 and cover member 13, the latter being tightly secured to member 5 by the screws 23 which penetrate the openings in the diaphragm and take into threaded recesses or inserts in the base portion 8 of member 5.

Relief valve 31 extends through diaphragm 12 and is provided with upper and lower shoulder portions 32 and 33 which are adapted to secure valve 31, disc 30 and an annular sealing washer 34 to diaphragm 12 in a fluid tight relation. Disc 30 is provided with a central opening and is preferably positioned above diaphragm 12 and secured between the latter and the upper shoulder portion 32 of valve 31. The sealing washer 34 is secured between the bottom face of diaphragm 12 and the lower shoulder 33. The upper shoulder is preferably formed as by spinning or riveting over a portion of the outer side wall of valve 31 after the assembly comprising the disc 30, diaphragm 12 and washer 34 has been positioned as above described with respect to the valve body of valve 31. Relief valve 31 is provided with two oppositely opening cylindrical recesses 35 and 36 which communicate through a circular passage 37 of smaller diameter. A ball 38, preferably made of polished steel, is disposed within recess 36 and is normally biased upwardly to seal the lower end of passage 37 by a small coiled compression spring 39 which bears at its lower end against an annular retaining ring 40 rigidly secured over the bottom end of valve 31 as by riveting over the end portion of the valve body. The lower end of a rod 41 is positioned within recess 35 and is adapted for limited lengthwise movement therein. Rod 41 is provided adjacent its lower end with a peripheral extension or shoulder 41^a which cooperates with a retaining ring 42 secured at the top end of valve 31 in the manner described in connection with retaining ring 40. Rod 41 has a lower end portion 41^b of reduced cross section which is adapted to project through the passage 37 when rod 41 moves downwardly thereby pressing the ball 38 downwardly and away from the lower end of passage 37 to permit flow of fluid from the lower to upper diaphragm chamber. Rod 41 is slidable within the opening 15 and is provided with a threaded upper end portion which threads into a member 43.

For the most part, the portion of the relay assembly thus far described comprises the diaphragm time delay means which is like that shown and described in the Kuhn et al. Patent No. 2,506,225, issued May 2, 1950. As will be later more fully explained, the time delay means provides an adjustable time interval between the energization of the relay electromagnetic operating coil and the closure of circuit commutating contacts.

A magnet frame 44 preferably formed of a soft steel, is secured to the upper side of the flanged base 7 of member 5 and has a solenoid operating coil 45 positioned therewithin. Magnet frame 44 comprises vertical portions 44^a and 44^b integrally connected with and projecting perpendicularly upwardly from a base portion 44^c by which frame 44 is secured to the base 7 of member 5 by a plurality of screws 7^a penetrating through suitable openings formed in the base portion 7 and taking into threaded recesses formed in the portion 44^c. A central cylindrical flanged opening is provided in the portion 44^c of frame 44 and is preferably formed by extrusion of the portion 44^c to provide a cylindrical flange 44^d. Adjacent their upper corners the portions 44^a and 44^b, are each sheared downwardly, the sheared corner portions being bent perpendicularly and being provided with threaded openings extending therethrough, forming supporting and attaching lugs for a steel plate 44^e which forms the upper side of magnet frame 44.

The plate 44^e is secured to the portions 44^a and 44^b by a plurality of screws which penetrate screw receiving openings formed therethrough and take into the threaded openings in the aforedescribed attaching lugs of portions 44^a and 44^b. A central circular opening extending through plate 44^e is provided to accommodate a portion 46^a of a cylindrical plunger stop 46 which has a portion 46^b of larger diameter depending downwardly below plate 44^e

The stop 46 which is of magnetic material is rigidly secured to the plate 44^e as by spinning or riveting over the end of the portion 46^a which terminates above plate 44^e. A downwardly opening frusto-conical recess 46^c is provided in the lower end of stop 46 which opening communicates with the upper end of the portion 46^a through a cylindrical passage 46^d.

A cylindrical tube 47, preferably formed of a non-magnetic metal such as brass, is secured adjacent its upper end about the portion 46^b of stop 46 with its inner wall engaging the cylindrical wall of the portion 46^b in a tightly fitting relation and with its upper end abutting against the plate 44^e. Tube 47 is secured adjacent its lower end by tight fitting engagement of its outer wall with the inside of the flange 44^d of magnet frame 44.

The solenoid coil 45 is disposed about the tube 47 within magnet frame 44 and is restrained against vertical movement by a spring-washer 48 which presses soid coil upwardly against the lower side of the plate 44^e.

A solenoid plunger 49, which is preferably formed of a magnetic type steel, is adapted to move upwardly within the tube 47 when the coil 45 is energized. Plunger 49 has a cylindrical portion 49^a which is somewhat less in diameter than the inner diameter of tube 47, and a cylindrical portion 49^b of relatively smaller diameter which joins with the portion 49^a at a sharply defined shoulder, and a frusto-conical portion 49^c which at its base merges into the portion 49^b. The frusto-conical portion 49^c of plunger 49 is complementary in form to the recess 46^c in stop 46 and is adapted to engage with the bottom of said recess to limit the upward movement of plunger 49. Plunger 49 is also provided with a cylindrical passage 49^d extending lengthwise thereof to accommodate a push rod 50 which projects through said plunger.

A coiled compression spring 51 is interposed within tube 47 to bias plunger 49 downwardly against the member 43. Spring 51 bears at its upper end against the lower end of the portion 46^c of member 46 and its lower end bears against the aforedescribed shoulder on plunger 49.

The push rod 50 which is preferably cylindrical in form also projects upwardly through the pas-

sage 46d of stop 46, a downwardly opening cylindrical recess 52a formed in a portion 52 of a contact lever 53, an opening 52b extending through portion 52 from the upper end of recess 52a and through and beyond an opening formed in a lug extension 54a of a portion 54 of contact lever 53. Adjacent its upper end rod 50 is threaded for a certain distance to accommodate a slotted nut 55 which is retained in a fixed position on rod 50 by a cotter key which projects through a transverse opening (not shown) drilled through rod 50 adjacent the upper end of the latter and a pair of oppositely disposed slots in nut 55. At its lower end rod 50 projects within the passage 43a of member 43 and is secured to said member by a pin which tightly fits within alined openings formed transversely through the enlarged cylindrical portion 43b of member 43 and rod 50. Rod 50 is of such diameter that it is adapted to freely move lengthwise within the above mentioned openings through which it projects.

The member 43 is also provided with a cylindrical portion 43c which is of smaller diameter than the portion 43b with which it joins at its upper end at a sharply defined shoulder. A guide 56 having an annular portion 56a is disposed about the portion 43c of member 43 and is retained against the lower end of the portion 43b of said member by a coiled compression spring 57. Guide 56 is also provided with a radially projecting lug portion 56b integrally formed with the portion 56a which is slidable within a vertical guide groove 58 formed in member 5; said guide groove merging at its open side with the recess 16 with which it is co-extensive in the vertical direction.

Spring 57 which is disposed about the portion 43c of member 43 bears at its upper end against the lower side of the portion 56a of guide 56 and at its lower ends against the end wall of recess 14. Spring 57 biases the assembly comprising rod 41, member 43, guide 56 and rod 50 for upward movement but the biasing force of spring 57 is preponderated by the opposing force of spring 51 and the weight of the plunger 49.

Contact lever 53 comprises the portion 52 which is preferably formed of a suitable molded insulating material and the portion 54 which is preferably made of metal. The portion 54 is essentially of inverted channel form in vertical cross section and said portion is rigidly attached to the portion 52 as by a pair of rivets which penetrate through alined openings formed in such portions. The lug extension 54a which is integrally connected with the upper horizontal side of portion 54 depends angularly upwardly towards the free end of the portion 52 and the aforementioned opening extending through said lug is in substantial axial alinement with the recess 52b and the opening 52a of the portion 52. Adjacent its free end, the portion 52 is of reduced rectangular cross section and is provided with a horizontal opening extending therethrough to provide for attachment of a knife blade type contact 59 which is best shown in Figs. 3 and 4. Contact 59 is provided with a channel shaped attaching portion 59a conforming to the reduced rectangular cross section of the portion 52 of lever 53 and has axially alined openings extending through the vertical legs thereof to accommodate a bolt 59c which penetrates through the openings in said vertical legs and the horizontal opening in the portion 52; said contact being rigidly secured to the portion 52 by a nut which

takes onto the threaded end of bolt 59c. A contact blade portion 59b of contact 59 extends transversely of lever 53 and upwardly and is adapted to bridge a pair of stationary contacts 61 and 62 incident to the energization of coil 45 as will later be more fully explained.

An essentially inverted U-shaped bearing bracket 63 is secured to the upper side of plate 44e of magnet frame 44 by a plurality of screws which penetrate through openings formed in the horizontally depending portions 63a and 63b and take into threaded openings formed in plate 44e, with a pair of such screws preferably providing for simultaneous securement of plate 44e to the aforementioned attaching lugs formed on the portion 44b of magnet frame 44. The portions 63a and 63b are respectively integrally connected with vertical portions 63c and 63d which are in a parallel spaced relation to each other and are integrally connected at their upper ends by a horizontal portion 63e which lies in the plane parallel with the portions 63a and 63b. The portions 63c and 63d are provided with axially alined openings to accommodate and provide bearing support for a pivot pin 64 on which contact lever 53 is supported. Vertical depending legs of the portion 54 of lever 53 have axially alined openings to accommodate the pin 64 which projects through and beyond the portions 63c and 63d. The pin 64 is secured against axial movement in any preferred manner such as by cotter keys which penetrate through transverse openings in pin 64 adjacent the ends thereof. Contact lever 53 is pivotally supported with a loose fit on pin 64 between the portions 63c and 63d and is adapted to be pivotally moved about said pin.

The portions 63c and 63d are also provided with axially alined openings to accommodate and provide bearing support for a pivot pin 65 on which a latch 66 is supported for pivotal movement. Pivot pin 65 is secured within said openings in the manner described in connection with pivot pin 64. Latch 66 is provided with an opening through which the pin 65 projects and said latch is pivotally supported on pin 65 equidistant between the portions 63c and 63d of bracket 63, there being tubular spacing member disposed about pin 65 on opposite sides of the latch.

Latch 66 is biased for pivotal movement in the counterclockwise direction (as viewed in Fig. 3) by a coiled torsion spring 67 which is disposed about one of the spacing members. One end of spring 67 is hooked over the upper side of latch 66 and the other end of said spring is hooked over an edge of the portion 63c of bracket 63. Latch 66 is provided with a cam portion 66a which is essentially of wedge shape and which is adapted to engage at a slightly rounded end thereof with the upper surface of a flat cam plate 68 and the end of a stop plate 69 which are rigidly secured to the upper side of the portion 54 of contact lever 53. Latch 66 is also provided with a portion 66b which is integrally connected with the portion 66a and which extends essentially at a right angle to the end of the portion 66a. The portion 66b of latch 66 is provided with a threaded vertical opening extending therethrough to accommodate a threaded screw 70 having an enlarged flat head which is adapted to provide an adjustable abutment on said latch. The screw 70 may be adjusted to a desired position and locked in such position by a nut which engages with screw 70 above the upper side of the portion 66b. As will be later more fully explained, the nut 55 on rod 50 is adapted to engage with the head of

screw 70 upon upward movement of said rod thereby to effect pivotal movement of latch 66 in the clockwise direction (as viewed in Fig. 3) against the bias of the spring 67.

Contact lever 53 is biased for pivotal movement in the clockwise direction (as viewed in Fig. 3) by a coiled compression spring 71. Spring 71 is disposed about push rod 50 and bears at its upper end against the end wall of recess 52a in portion 52 of lever 53 and its lower end bears against the inner surface of a flanged retaining member 72 which is disposed about rod 50 and which abuts against the riveted end of the portion 46a of the stop 46. Spring 71 is restrained against lateral movement by the side wall of recess 52a at its upper end and at its lower end by the flange of retaining member 72.

The contacts 61 and 62 each comprise a pair of cooperating spring type contact jaws within which blade 59b of contact 59 penetrates for bridging of contacts 61 and 62 as an incident to pivotal clockwise movement of contact lever 53 as will later be more fully explained. Contacts 61 and 62 are each secured to an insulating vertical contact board 73 adjacent the upper end of the latter in a spaced relation to each other. Each of these contacts is rigidly attached to a bolt as by welding and these bolts penetrate openings extending through the board 73 and are threaded adjacent their ends to provide for threaded engagement with a pair of nuts which hold the respective contact assemblies in a rigid relation to such board and which also provide for making circuit connection with the contacts 61 and 62.

Contact board 73 adjacent its lower end is secured to the outside of the portion 44a of magnet frame 44 by a pair of threaded attaching posts 74 and 75 which penetrate through openings formed in board 73 and by nuts which take onto threaded end portions of said posts to hold contact board 73 rigidly against the portion 44a of magnet frame 44. Posts 74 and 75 are secured to the portion 44a of frame 44, as by welding the respective reduced end portions of such posts, which penetrate through openings formed in the portion 44a, to said portion 44a.

A hood 76 formed of insulating material is secured to contact board 73 as by a screw 77 which penetrates an opening provided in board 73 and takes into a threaded recess (not shown) formed in such hood. The hood 76 together with the upper end of contact board 73 provided a partial enclosure for contacts 61 and 62 whose respective pairs of jaws open downwardly slightly below the lower end of hood 76. Hood 76 is suitably formed to accommodate lateral movement of such contact jaws therewithin and is also provided with a downwardly opening vertical notch (not shown) to accommodate the portion 52 of lever 53 when the latter moves pivotally upwardly to effect engagement of contact blade 59b with contacts 61 and 62.

A rectangular strip 78 formed of insulating material is secured to the upper side of plate 44e of magnet frame 44 underlying contact 59 and contacts 61 and 62. At one side thereof strip 78 abuts against contact board 73 and is preferably secured to plate 44e by a pair of the screws which are provided for securement of said plate to the vertical portion 44a of magnet frame 44 as aforedescribed. Thus strip 78 together with contact board 73 and the hood 76 insure that electrical arcs will not be drawn across to magnet frame 44 as an incident to disengagement of contact 59 from contacts 61 and 62.

As will be understood, the spring 51 is of such character that when in its extended condition shown in Fig. 3 it together combined with the weight of plunger 49 and the assembly comprising rod 41, member 43, guide 56, rod 50 and the nut 55 will be sufficient to overcome the opposing bias of the springs 57 and 71 and retain the plunger 49, said assembly and contact lever 53 in their extreme downward positions depicted in Fig. 3.

The operation of the relay will now be described.

Referring particularly to Fig. 3, it shows the aforedescribed parts of the relay in the respective positions ultimately assumed as an incident to de-energization of coil 45. Upon energization of coil 45 the plunger 49 quickly moves upwardly within member 47 against the bias of spring 51 and said plunger engages the stop 46 by abutment of its portion 49c with the bottom of the recess 46c and plunger 49 remains in such position so long as coil 45 is energized. The assembly comprising rod 41, member 43, guide 56 and rod 50 therefore tends to move upwardly under the bias exerted by spring 57 but such movement is retarded. During slight vertical upward movement of the latter assembly, the end 41b of rod 41 moves out of engagement with ball 38 which then seals passage 37 in relief valve 31 under the bias of spring 39. Also upon initial movement of rod 41 its shoulder 41a comes into engagement with the retaining ring 42. Thus continued movement of rod 41 causes the assembly comprising diaphragm 12, disc 30, and valve 31 to follow in upward movement. However, the last mentioned assembly retards the rate of upward movement of rod 41, member 43, guide 56 and rod 50 by virtue of a vacuum produced in the lower diaphragm chamber and thereafter rod 41, member 43, guide 56 and rod 50 move upwardly at a controlled rate depending upon the rate that air or other fluid can flow from the upper diaphragm chamber through passages 27, 26, 24 and 25 into the lower diaphragm chamber. The rate of flow of air on other fluid from the upper to the lower diaphragm chamber may be varied by, adjusting needle valve screw 28 so that its tapered end portion 28b increases or decreases the effective opening through the tapered passage 25.

As the rod 50 moves upwardly, the nut 55 disengages from the lug 54a and ultimately engages the aforedescribed enlarged head of screw 70. On continued upward movement of rod 50, latch 66 is pivotally moved in the clockwise direction against the bias of spring 67. Clockwise pivotal movement of latch 66 effects disengagement of its cam portion 66a from the end of the stop plate 69 and finally effects disengagement of said cam portion from the upper surface of cam plate 68 whereupon the lever 53 becomes unlatched and pivotally moves in the clockwise direction with snap action under the bias of the spring 71. Such movement of lever 53 causes the blade 59b of contact 59 to be interposed between the aforedescribed cooperating spring jaws of contacts 61 and 62; the jaw pairs of the respective contacts yielding laterally to accommodate the blade 59b therebetween. Thus the contacts 61 and 62 are bridged by the blade 59b of contact 59 to afford completion of circuit between contacts 61 and 62.

Upon subsequent de-energization of coil 45, the plunger 49 will quickly move downwardly to its initial position under the bias of spring 51.

In moving downwardly, plunger 49 causes the assembly comprising rod 41, member 43, guide 65 and rod 50 to move downwardly therewith. During the initial downward movement the shoulder 41a of rod 41 moves out of engagement with retaining ring 42 and the lower end portion 41b moves into engagement with the ball 38 thereby to force the latter away from the lower end of passage 37. Depressing the ball 38 away from the end of passage 37 thereby permits substantially unrestricted passage of air or other fluid from the upper to the lower diaphragm chambers through the valve 31. Thereafter further downward movement of rod 41, member 43 and rod 50 as well as plunger 49 is obtained at a rapid rate with the assembly comprising diaphragm 12, disc 30 and valve 31 moving downwardly at the same rate.

As rod 50 and the nut 55 move downwardly, the latch 66 moves pivotally in the counterclockwise direction under the bias of spring 67. Ultimately the nut 55 disengages from the head of screw 70 and thereafter engages the lug 54a of lever 53. On continued downward movement of rod 50 and nut 55, contact lever 53 is caused to move pivotally in the counterclockwise direction against the bias of the spring 71 to effect disengagement of blade 59b from contacts 61 and 62; such disengagement of blade 59b from contacts 61 and 62 being essentially with snap action. By the time lever 53 has assumed its normal position, the latch 66 will have pivotally moved in the counterclockwise direction sufficiently to effect engagement of its cam portion 66a with the upper side of cam plate 68 and with the end of stop plate 69 thereby to positively latch contact lever 53 in its lower position with the contact blade 59b of contact 59 disengaged from the stationary contacts 61 and 62.

The aforedescribed abutment screw 70 of latch 66 affords adjustment of the point in the upward travel of the push rod 50 at which contact lever 53 is released for clockwise pivotal movement by the tripping of latch 66 out of engagement with the cam plate 68. Preferably the adjustment of screw 70 should be such that contact lever 53 is released for clockwise pivotal movement just before the rod 50 reaches the limit of its upward travel, thereby affording the maximum retarding effect to be obtained from the diaphragm time delay means.

In like manner the nut 55 on the rod 50 may be adjusted to cause the contact lever 53 to be moved to its lower position at a certain point in the downward travel of rod 50. Preferably the adjustment of nut 55 should be such that contact lever 53 is just moved to its lower position when the guide 56 engages the bottom wall of recess 16 in member 55 thereby insuring against forced engagement of lever 53 with the insulating strip 78 on plate 44e of magnet frame 44.

Because of the aforedescribed construction the instant relay possesses features which make it resistant to unwanted changes of either of its operating conditions under high intensity shock. Certain features of this relay make it inherently shock resistant as will now be described.

In considering the behavior of the relay under such shock conditions, the vertical component of shock waves need only be seriously considered. As a first case assume that the relay is in its inoperative condition which it ultimately assumes as an incident to deenergization of solenoid coil 45. The vertical components of shock waves will tend to move plunger 49 upwardly and the assembly comprising rod 41, member 43, guide 56 and rod 50 would then tend to move upwardly. However, upward displacement of rod 41 will cause ball 38 to seal passage 37 and the above assembly would only move freely in the upward direction for a short distance before it is opposed by the retarding force of diaphragm 12 due to the partial vacuum produced in its lower diaphragm chamber. Further the energy of plunger 49 is rapidly dissipated by the biasing force of spring 51 and would be returned to its lower position before the nut 55 on rod 50 could engage the screw 70 of latch 66. Although latch 66, due to its own inertia might pivotally move against the bias of the torsion spring 67 and thereby effect disengagement of its cam portion 66a from cam plate 68, since rod 50 would only move a short distance upwardly lever 53 would not move sufficiently to permit engagement of contact blade 59b with the stationary contacts 61 and 62.

Now consider the case when the relay is in its operated condition ultimately assumed as an incident to energization of coil 45 with the contact blade 59b bridging contacts 61 and 62. The vertical component of shock waves will tend to move plunger 49 downwardly away from the stop 46 but such tendency is opposed by the magnetic pull provided by coil 45. Inasmuch as the nut 55 is disengaged from lug 54a of contact lever 53 some downward travel of rod 50 can be tolerated and any such travel of rod 50 would not be sufficient to cause engagement of nut 55 with the lug 54a. Contact lever 53 itself would only tend to move pivotally in the counterclockwise direction due to its own inertia which is effectively counterbalanced by the biasing force of the spring 71. Any shock transmitted to lever 53 through pivot pin 64 would not cause rotation of lever 53. Further the gripping action of the jaws of contacts 61 and 62 on contact blade 59b of contact 59 would also tend to counteract any pivotal movement of lever 53. Although the jaws of contacts 61 and 62 might spread laterally they inherently restore themselves and any such spreading would be of momentary duration and insufficient to permit contact blade 59b to drop out of its bridging relation with contacts 61 and 62.

What I claim as new and desire to secure by Letters Patent is:

1. In combination, cooperating contacts, biasing means for certain of said contacts, latching means for the latter of said contacts to restrain the same in a given position against the bias of said means, said latching means being biased to latching position, a member movable in one direction to trip said contact latching means and in an opposite direction to free said latching means therefrom and to reset said certain of said contacts against the bias of the first mentioned means in a position to be again latched, operating means for moving said member in opposite directions selectively comprising a spring device in which energy is stored by movement of said member in said opposite direction for expenditure to move said member at a regulable speed in latch tripping direction.

2. In combination, cooperating contacts, biasing means for certain of said contacts, latching means for the latter of said contacts to restrain the same in a given position against the bias of said means, said latching means being biased to latching position, a member movable

in one direction to trip said contact latching means and in an opposite direction to free said latching means therefrom and to reset said certain of said contacts against the bias of the first mentioned means in a position to be again latched, operating means for moving said member in opposite directions selectively comprising a spring device in which energy is stored by movement of said member in said opposite direction for expenditure to move said member at a regulable speed in latch tripping direction and further comprising a preponderating spring to move said member to store energy in said spring device and an electromagnet which when energized relieves said member of the influence of said preponderating spring.

3. In combination, cooperating contacts including a contact carrying lever movable between opposite extreme positions, means constantly biasing said lever toward one extreme position, a latch to restrain said lever in its opposite extreme position, means constantly biasing said latch into restraining relation with said lever, a member constantly under bias for movement in a direction to trip said latch, said member being movable in the reverse direction against its bias to free said latch therefrom and to move said lever to effect disengagement of said contacts, electromagnetic means controlling said member, including means selectively to release said member for movement under its bias and to move said member against its bias according to the electrical condition of said electromagnetic means, and means which upon movement of said member in latch tripping direction introduces time delay in such movement.

4. In combination, cooperating contacts, a lever carrying certain of said contacts and movable selectively to effect engagement or disengagement of said contacts, means constantly biasing said lever for movement to effect engagement of said contacts, a latch to restrain said lever in a position disengaging said contacts, means constantly biasing said latch into restraining relation with said lever, a member constantly under bias for movement in a direction to trip said latch, said member being movable in the reverse direction against its bias to free said latch therefrom and to move said lever to effect disengagement of said contacts, electromagnetic means controlling said member, including means selectively to release said member for movement under its bias or to move said member against its bias according to the electrical condition of said electromagnetic means, and means which upon movement of said member in latch tripping direction introduces regulable time delay in such movement.

5. In combination, a pair of contacts each of which comprises cooperating spring jaws adapted to grip a blade contact interposed therebetween, a blade contact for bridging the former contacts, a lever carrying said bridging contact, means constantly biasing said lever for movement to effect engagement of said contacts, a latch to restrain said lever in a position disengaging said contacts, means constantly biasing said latch into restraining relation with said lever, a member constantly biased for movement in a direction to trip said latch, said member being movable against its bias to free said latch therefrom and to move said lever to effect disengagement of said contacts, electromagnetic means controlling said member, including means selectively to release said member for movement under its bias or to move said member against its bias according to the electrical condition of said electromagnetic means, and means which upon movement of said member in latch tripping direction introduces regulable time delay in such movement.

6. In combination, cooperating contacts, a lever carrying certain of said contacts and movable selectively to effect engagement or disengagement of said contacts, means constantly biasing said lever for movement to effect engagement of said contacts, a latch to restrain said lever in a position disengaging said contacts, means constantly biasing said latch into restraining relation with said lever, a member movable in one direction to trip said latch and movable in the opposite direction to free said latch therefrom and move said lever against its bias to a position disengaging said contacts wherein it is again latched, a spring biasing said member for movement in said one direction, a preponderating spring to move said member in said opposite direction to store energy in the former spring, an electromagnet which when energized relieves said member of the influence of said preponderating spring, and means which upon movement of said member in latch tripping direction introduces regulable time delay in such movement.

7. In combination, a pair of contacts each of which comprises cooperating spring jaws adapted to grip a blade contact interposed therebetween, a blade contact for bridging the former contacts, a pivotally supported lever carrying said bridging contact, spring means constantly biasing said lever for movement to effect engagement of said contacts, a pivotally supported latch, spring means constantly biasing said latch in a direction to engage said lever, said lever having a part with which a portion of said latch is adapted to frictionally engage when said lever is moved to a position disengaging said contacts for locking it in such position, a member, spring means constantly biasing said member in a direction to trip said latch to permit snap-action movement of said lever to a contact engaging position, said member being movable against its bias to free said latch therefrom and to move said lever to said contact disengaging position wherein it is again locked by said latch, electromagnetic means controlling said member for movement under its bias or to move said member against its bias according to the electrical condition of said electromagnetic means, and means which upon movement of said member in latch tripping direction introduces regulable time delay in such movement.

8. In combination, a pair of contacts each of which comprises cooperating spring jaws adapted to grip a blade contact interposed therebetween, a blade contact for bridging the former contacts, a pivotally supported lever carrying said bridging contact, spring means constantly biasing said lever for movement to effect engagement of said contacts, a pivotally supported latch, spring means constantly biasing said latch in a direction to engage said lever, said lever having a part with which a portion of said latch is adapted to frictionally engage when said lever is moved to a position disengaging said contacts for locking it in such position, a member, spring means constantly biasing said member in a direction to trip said latch to permit snap-action movement of said lever to a contact engaging position, said member being movable against its bias to free said latch therefrom and to move said lever to said contact disengaging position wherein it is again locked by said latch, said latch additionally having an adjustable part in the path of said

member which according to its adjustment determines the movement of said member required for tripping said latch, electromagnetic means controlling said member for movement under its bias or to move said member against its bias according to the electrical condition of said electromagnetic means, and means which upon movement of said member in latch tripping direction introduces regulable time delay in such movement.

9. In combination, a pair of contacts each of which comprises spring jaws adapted to grip a blade contact interposed therebetween, a blade contact for bridging the former contacts, a pivotally supported lever carrying said bridging contact, spring means constantly biasing said lever for movement to effect engagement of said contacts, a pivotally supported latch, spring means constantly biasing said latch in a direction to engage said lever, said lever having a part with which a portion of said latch is adapted to frictionally engage when said lever is moved to a position disengaging said contact for locking it in such position, a member movable in one direction to trip said latch to permit snap-action movement of said lever to a contact engaging position

and movable in the opposite direction to free said latch therefrom and to move said lever against its bias to said contact disengaging position wherein it is again locked by said latch, a spring biasing said member for movement in said one direction, a preponderating spring to move said member in said opposite direction to store energy in the former spring, an electromagnet which when energized relieves said member of the influence of said preponderating spring, and means which upon movement of said member in latch tripping direction introduces regulable time delay in such movement.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,029,137	Stevens	Jan. 28, 1936
2,266,804	Roby	Dec. 23, 1941
2,308,660	Kouyoumjian	Jan. 19, 1943