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METHOD OF ASSEMBLING A RELAY

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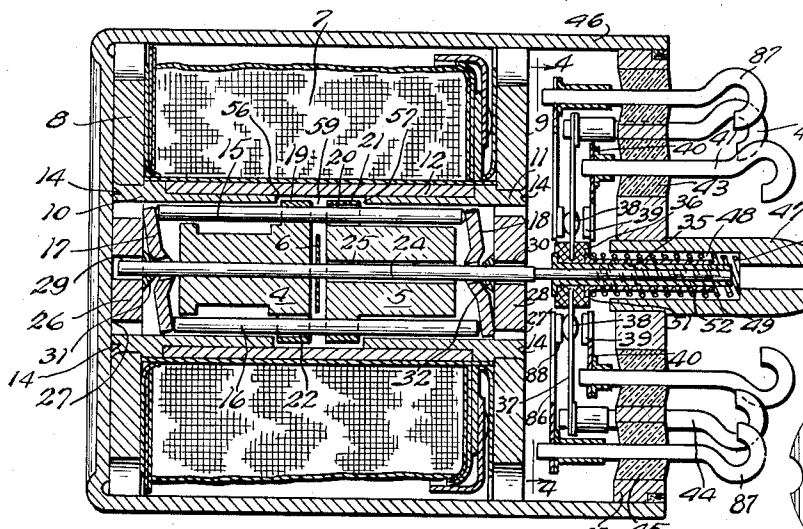


Fig. 1.

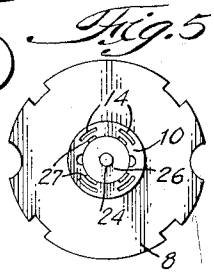


Fig. 5

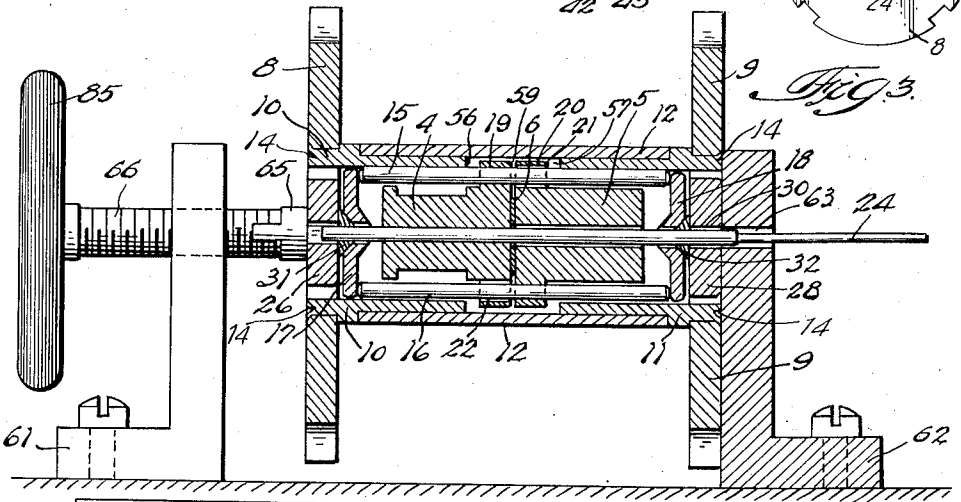


Fig. 3.

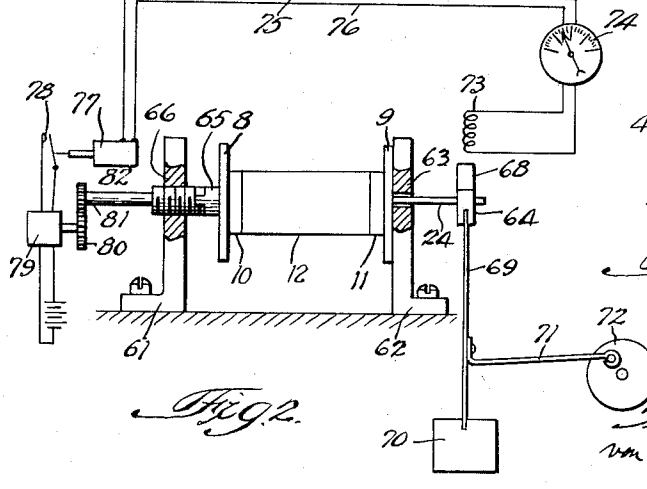


Fig. 2.

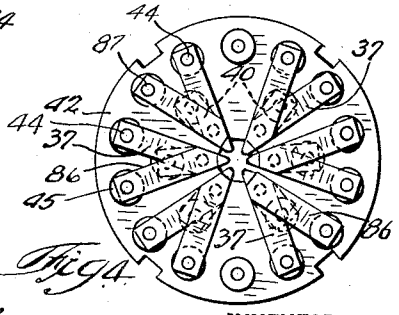


Fig. 4

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METHOD OF ASSEMBLING A RELAY

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This invention relates to the method of assembling a magnetic relay mechanism, whereby parts of the mechanism totally enclosed within a hollow core of the magnet may be adjusted to have optimum interengagement, a condition in which the parts operate together smoothly and easily, without loose interplay, stiffness, or a tendency to bind.

More particularly, the invention is directed to the method of assembling an electromagnetic relay of a type of construction that is provided with safeguards against false contact operation caused by forces of acceleration, shock or vibration. For example, this invention is useful in assembling a relay having core members positioned to move toward and away from each other and intercoupled by a motion interlocking mechanism to prevent independent movement of the parts, including the core members, and to subject them to counteraction one by another under shock or vibration. Such interlocking mechanism may be composed of pins coupled one to the other by rocker members. Each pin is secured to a different one of the core members and passes loosely through the other core member, and each of the rocker members is coupled to different and corresponding end portions of the pins. A contact actuating arm is secured to one of the core members and passes freely through the other core member, such that movement of the attached core member relative to the relay frame is required to actuate the relay contacts.

The assembly of this type of relay involves problems that are difficult to solve because adjustment of the parts to eliminate looseness or clearance at the points of engagement, say, between the pins and the rocker members, in order to provide positive contact action, has to be made after the parts are in place and totally enclosed. The elimination of looseness or clearance at the points of engagement of these parts entails the establishment of intercontact without causing binding or a tendency toward stiffness of operation. A still further difficulty in making this assembly involves positioning the parts so that after the looseness or clearance is eliminated, the various magnetic gaps between the plungers and the back gaps will be in propor proportional relation in order to assure prompt and positive action of the plungers when energized. In fact, the essential design and arrangement of these parts increases the difficulty, because the final assembly and adjustment of these parts must be made blind, so to speak, but still so accurately that the clearance or looseness between the parts must be eliminated with the parts just engaging each other, and no more, in order to achieve proper operation of relay contacts.

An object of the invention is to provide a new and improved method of positioning enclosed movable parts to eliminate clearance or looseness between them, said method comprising the performance of an operation at a point exterior to the enclosure to move the parts into engagement with each other without applying stiffening or binding therebetween.

Another object of the invention is to provide, for an

electromagnetic relay, a new and improved method of adjustably assembling its movable parts to assure optimum performance under any and all severe ambient conditions, said method involving the positioning of the movable parts to eliminate clearance between them preferably from a point exterior of the relay to bring the parts into engagement with each other.

A still further object of the invention is to provide a new and improved method of assembling the parts of an electromagnetic relay and of adjusting certain of the operating parts whereby to secure proper proportioning of the magnetic gaps and to eliminate looseness between these parts in order to effect optimum performance under any and all severe conditions of use.

Other objects and advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawings which form a part thereof.

In the drawings:

Figure 1 is a longitudinal section of an electromagnetic relay assembled and adjusted in accordance with a method incorporating the features of the present invention;

Fig. 2 is a layout of the apparatus for practicing the present invention;

Fig. 3 is a longitudinal section similar to the view shown in Fig. 1;

Fig. 4 is an elevation of the inside face of the contact carrying head; and

Fig. 5 is an end view of the sleeve members of the spool to show the anchoring of the end plates therein.

There is shown in Figure 1 an electromagnetic relay having internally disposed movable elements in the form of plungers or armatures 4 and 5 adapted to move toward each other until stopped by the residual or spacer 6 on being energized by coil 7. The armature plungers 4 and 5 are made of a magnetic material such as soft iron. The spacer 6 is made of a non-magnetic material such as brass in order to prevent the armature plungers 4 and 5 from sticking together as the result of residual magnetism. The spool of the relay includes spool ends 8 and 9 carried by sleeve members 10 and 11 respectively between which sleeve members sleeve 12 extends. Spool ends 8 and 9 and sleeve members 10 and 11 are made of magnetic material such as soft iron, while sleeve 12 is made of non-magnetic material such as brass. Sleeve members 10 and 11 are keyed at 14 to spool ends 8 and 9 while sleeve 12 is preferably fixed to sleeve members 10 and 11 as by tack welding at various points around their peripheries after the internally disposed elements have been properly adjusted in accordance with the features of the present invention.

The relay is of a construction that is provided with safeguards against various contact operations caused by forces of acceleration, shock or vibration. The armatures 4 and 5 are intercoupled by a motion interlocking mechanism to prevent independent movements of the parts, including these armatures, and to subject them to counteraction one by another under shock or vibration. To this end, the interlocking mechanism is composed of pins 15 and 16, made of a non-magnetic material such as stainless steel, coupled one to the other by rocker members 17 and 18 made of a non-magnetic material such as brass. Pin 15 is secured to armature 4 by a tight fit with integral sleeve 19 and it passes loosely through armature 5 due to the large opening in sleeve 21. Pin 16 is secured to armature 5 by a tight fit in flange 20, but passes loosely through flange 19 of armature 4 by reason of an enlarged opening 22. A contact actuating arm 24 is secured to armature 4 by reason of a tight fit but passes loosely through an enlarged central opening 25 in armature 5.

An end plate 26 made of a non-magnetic material such

as brass is driven tightly into sleeve member 10 and is keyed to the same at a plurality of points designated 27. Similarly, an end plate 28, also made of non-magnetic material such as brass, is tightly driven into the opposite sleeve member 11 and is also keyed at points designated 27' to this sleeve member. End plates 26 and 28 are provided with openings 29 and 30 respectively of a larger diameter than contact actuating arm 24 which carries rockers 17 and 18. Anvils 31 and 32 are formed upon the inside face of end plates 26 and 28 and the openings 29 and 30 extend therethrough. These anvils 31 and 32 function as a mounting or point about which rockers 17 and 18 rock or pivot when moved by pins 15 and 16.

Contact actuating arm 24 projects forwardly through end plate 28 and carries an insulating sleeve 35 supporting an insulating collar 36. Anchored in collar 36 are the inner tips of a plurality of spring contact arms 37 carrying movable contacts 38 adapted to effect a make-and-break action with contacts 39 carried on a plurality of spring fingers 40 suitably attached to an inner row of terminal connectors 41 disposed in a header 42 by glass seals 43. Spring contact members 37 are likewise carried on similar terminal connectors 44 mounted in an outer row in header 42 by glass seals 45. A third set of contacts 88 normally engaged by movable contacts 38, when the relay is de-energized, is carried by a set of spring members 86 also carried by terminal connectors 87 arranged in an outer row but staggered between outer connectors 44.

When it is desirable to seal all contacts and interior parts and possibly pressurize the interior with an inert gas such as dry nitrogen or helium gas, header 42 may be carried in a gas-tight case 46 of magnetic material that serves to complete the magnetic field when coil 7 is energized. A fill tube 47 is fixed to header 42 and provides a chamber 48 for a contact return spring 49. Spring 49 lies between shoulder 50 of filler tube 47 and shoulder 51 of a sleeve 52 disposed between sleeve 35 and spring 49. As is well understood in the art, the interior of case 46 may be evacuated through fill tube 47 and then charged with an inert gas under pressure, fill tube 47 being sealed at its tip 55.

To obtain optimum performance of the relay, magnetic gaps 56 and 57 must have a predetermined physical and magnetic relationship to the magnetic gap 59 between armatures 4 and 5. Inasmuch as the magnetic force developed in gaps 56 and 57 when coil 7 is energized works against the force produced in gap 59, the former gaps may be referred to as back gaps. The relationship between gap 59 and gaps 56 and 57 required for optimum relay operation is that the physical dimensions of gaps 56 and 57 must be such that the magnetic forces developed thereby are substantially equal, and will be less than the magnetic force developed across gap 59.

In assembling the relay, spool end 8 and end plate 26, and spool end 9 and end plate 28 may be fitted to sleeves 10 and 11 respectively. Next, sleeve 12 may be fitted onto sleeve 11. When this is accomplished, rocker arm 18, actuating arm 24, armatures 4 and 5, with interconnecting pins 15 and 16 respectively, spacer 6, and rocker arm 17 may be assembled and inserted into sleeve 12. Fnally, the subassembly of sleeve 10, spool end 8 and end plate 26 is fitted to the open end of sleeve 12 by inserting the end of sleeve 10 into sleeve 12 until the end of actuating arm 24 enters the opening 29 of end plate 26. At this stage of assembly the motion interlocking mechanism comprised of pins 15 and 16 and rocker arms 17 and 18 is totally enclosed and is characterized by loose interplay resulting from lack of interengagement at all of the intended bearing points between the pins and rocker arms. This undesirable condition can be remedied, however, and final assembly and adjustment to eliminate loose interplay may be effected easily by applying the method of this invention.

In Fig. 2 an apparatus for use in practicing this invention is illustrated. With this device, the necessary final assembly and adjustment of the concealed armature assembly can be made. This apparatus comprises a fixture in the form of two fixed brackets 61 and 62 adapted to receive the relay before coil 7 is wound about sleeve 12. Contact actuating arm 24 projects through an enlarged opening 63 in bracket 62 and has a clamp 64 secured thereto near its outer end. At opposite end of the relay is a permanent magnet 65 engaging a threaded shaft 66 carried in bracket 61. Permanent magnet 65 is arranged in driving relation with threaded shaft 66. At the opposite end, clamp 64 is adapted also to carry a permanent magnet 68. Clamp 64 and this permanent magnet 68 are mounted on a resilient arm 69 anchored in base 70. Arm 69 is flexed back and forth by a connecting rod 71 driven by a rotating wheel 72. A pickup coil 73 is mounted over permanent magnet 68. As permanent magnet 68 is swept back and forth under coil 73, it generates a voltage which is indicated on meter 74. Meter 74 is connected in a relay circuit defined by wires 75 and 76 so that a relay 77 may be energized to close switch 78 in the circuit of an electric motor 79 adapted to drive a gear 80 in mesh with a gear 81 on shaft 82 connected to threaded shaft 66.

Figs. 2 and 3 illustrate the relay carried between brackets 61 and 62 with permanent magnet 65 in driving relation with threaded shaft 66. In Fig. 3, shaft 66 is shown provided with a hand knob 85 while in Fig. 2 shaft 66 is driven by motor 79 through gears 80 and 81 and shaft 82. In either case, the contact actuating arm 24 projects through opening 63 in bracket 62 and permanent magnet 65 creates a magnetic field causing armatures 4 and 5 to move toward each other and against spacer 6. If any looseness or clearance exists between rockers 17 and 18 and the respective ends of interconnecting pins 15 and 16, the movement of contact actuating arm 24 will not secure optimum performance of the relay in the closing action of contacts 38 and 39. Such clearance or looseness will also produce magnetic gaps 56 and 57 that are too small, and, therefore, are not in proper ratio with center gap 59. I have found that the proper ratio of these gaps may be established when a magnetic field is created by permanent magnet 65, the armatures 4 and 5 are drawn together against spacer 6, and the parts of the relay are moved together through application of pressure at part 65 until the ends of interconnecting pins 15 and 16 engage the rocker members 17 and 18 without causing a tendency toward binding or stiffness in relay operation. With the parts made according to dimension, the sleeves 10, 11, and 12 may be assembled tightly together, and the proper ratio of the gaps assured. Sleeve 12 may then be tack-welded about its peripheral ends with sleeves 10 and 11 to lock all the parts into a permanent spool unit. The pressure applied to magnet 65 should be just enough to eliminate looseness, the engagement between the rockers 17 and 18 and the interconnecting pins 15 and 16 being just snugly made but not tight. In other words, any pressure applied at the point of engagement between these parts should be insufficient to produce a tendency toward binding or stiffness in their interaction.

In the form of apparatus shown in Fig. 2, clamp 64 in combination with flexible arm 69 may move the contact actuating arm 24 back and forth to generate a voltage at pickup coil 73. The amplitude of the generated voltage will indicate the amount of movement of contact actuating arm 24. If there is movement or looseness, the relay circuits 75 and 76 will close and actuate relay 77 to close switch 78. Thereupon, the motor 79 will drive threaded shaft 66 forwardly through the gear connections 80, 81 and 82. This forward movement of threaded connection 66 will move the relay parts together enough to remove any clearance between interconnecting pins 15 and 16 and the rocker members 17 and 18. As soon as the clearance is eliminated, contact actuating arm 24 will no longer move, and, consequently, no voltage will be

generated at coil 73 and relay 77 will be de-energized to stop operation of motor 79.

When the looseness or clearance is thus eliminated between the interconnecting pins 15 and 16 and the rocker arms 17 and 18, and the armatures 4 and 5 have been centered by being drawn together against spacer 6, it will be found that air gaps 56 and 57 will be in proper ratio to center air gap 59. When permanent magnet 65 is removed, and the armatures 4 and 5 are returned to the de-energized position, as when contact return coil spring 49 is assembled and in position, the central magnetic gap 59 may then be substantially greater than the back gaps 56 and 57, this being shown in Fig. 1. It is desirable to make back gaps 56 and 57 as small as possible so that the reluctance of the magnetic paths between sleeve 10 and armature 4, and sleeve 11 and armature 5 may be minimized.

It will be apparent from the foregoing description that this method of finally assembling and adjusting totally enclosed parts of the relay will produce optimum performance of the relay under any and all severe conditions of use. The method is simple and very effective and quickly and accurately removes this objectionable looseness without applying any excessive pressure at the points of engagement of pins 15 and 16 with rockers 26 and 28. The action of the movable contacts 38 is always positive and makes proper engagement each time the relay is energized with contacts 39.

Without further elaboration, the foregoing will so fully explain the character of my invention that others may, by applying current knowledge, readily adapt the same for use under varying conditions of service, without eliminating certain features, which may properly be said to constitute the essential items of novelty involved, which items are intended to be defined and secured to me by the following claims.

I claim:

1. A method of adjustably assembly parts of a relay having spool ends and a sleeve arranged in a fixed relation therebetween, axially aligned magnetic plungers disposed in the spool between said ends, a pair of pins for interconnecting said plungers to prevent independent movements thereof and to subject them to counteraction one by another under shock or vibration, a centrally disposed contact actuating rod movable by said plungers, a spacer on said actuating rod between said plungers, pivotally carried rockers on said actuating rod for engaging the ends of said interconnecting pins, and anvils at said spool ends against which said rockers pivot, which method of adjustably assembling said relay parts to eliminate looseness between said rockers and said interconnecting pins comprises: magnetically energizing said plungers to move them toward each other and against said spacer, then moving at least one of said anvils toward said rockers until the ends of said interconnecting pins engage both of said rockers.

2. A method of adjustably assembling parts of a relay having spool ends and a sleeve therebetween arranged in a fixed relation, axially aligned magnetic plungers disposed in the spool between said ends, a pair of pins for interconnecting said plungers to prevent independent movements thereof and to subject them to counteraction one by another under shock or vibration, a centrally disposed contact actuating rod movable by said plungers, a spacer on said actuating rod between said plungers, pivotally carried rockers on said actuating rod for engaging the ends of said interconnecting pins, and anvils at said spool ends against which said rockers pivot, the method of assembling said relay parts to eliminate looseness between said rockers and said interconnecting pins, which method comprises: magnetically energizing said plungers to move them toward each other and against said spacer, then moving at least one of said anvils toward said rockers, and simultaneously testing said actuating rod for said looseness until both ends of said interconnecting pins engage both of said rockers.

3. A method of adjustably assembling parts of a relay having spool ends and a sleeve therebetween arranged in a fixed relation, axially aligned magnetic plungers disposed in the spool between said ends, a pair of pins for interconnecting said plungers to prevent independent movements thereof and to subject them to counteraction one by another under shock or vibration, a centrally disposed contact actuating rod movable by said plungers, a spacer on said actuating rod between said plungers, pivotally carried rockers on said actuating rod for engaging the ends of said interconnecting pins, and anvils at said spool ends against which said rockers pivot, which method of adjustably assembling said relay parts to eliminate looseness between said rockers and said interconnecting pins comprises: magnetically energizing said plungers to move them toward each other and against said spacer, then moving said rockers toward said pins until the ends of said pins engage said rockers.

4. A method of adjustably assembling parts of a relay having spool ends and a sleeve arranged in a fixed relation therebetween, axially aligned magnetic plungers disposed in the spool between said ends, a pair of pins for interconnecting said plungers to prevent independent movements thereof and to subject them to counteraction one by another under shock or vibration, a centrally disposed contact actuating rod movable by said plungers, a spacer on said actuating rod between said plungers, pivotally carried rockers on said actuating rod for engaging the ends of said interconnecting pins, and anvils at said spool ends against which said rockers pivot, which method of adjustably assembling said relay parts to eliminate looseness between said rockers and said interconnecting pins comprises: magnetically energizing said plungers to move them toward each other and against said spacer, then moving said rockers toward said pins until the ends of said pins engage both of said rockers and the magnetic gap between said plungers is centrally positioned between said spool ends.

5. A method for adjustably assembling parts of a relay having spool ends, sleeve members carrying said ends and a sleeve spanning said members and locking them with said ends into a rigid unit, a centrally disposed contact actuating rod, axially aligned magnetic plungers disposed on said actuating rod in said sleeve, a spacer on said actuating rod between said plungers, a pair of pins for interconnecting said plungers to prevent independent movements thereof and to subject them to counteraction one by another under shock or vibration, rocker members on said actuating rod for engaging the ends of said interconnecting pins, and pivotal mountings for said rocker members, which method of adjustably assembling said relay parts to eliminate looseness between said rockers on said interconnecting pins comprises: magnetically energizing said plungers to move them toward each other, and against said spacer, then effecting relative movement of said pivotal mountings to move the said rocker members until both ends of said interconnecting pins engage both of said rocker members and said plungers and the magnetic gap between said plungers is substantially centered between said spool ends.

6. A method for adjustably assembling parts of a relay having spool ends, sleeve members for carrying said ends and a sleeve spanning said members and for rigidly interlocking said members with said ends to form a rigid spool, a centrally disposed contact actuating rod, axially aligned magnetic plungers disposed on said actuating rod in said spool, a spacer on said actuating rod between said plungers, a pair of pins for interconnecting said plungers to prevent independent movements thereof and to subject them to counteraction one by another under shock or vibration, rocker members on said actuating rod for engaging the ends of said interconnecting pins, and pivotal

mountings for said rocker members, which method of adjustably assembling said relay parts to eliminate looseness between said rockers and said interconnecting pins comprises: magnetically energizing said plungers to move them toward each other and against said spacer; then effecting relative movement of said pivotal mountings to move the said rocker members until both ends of said interconnecting pins engage both of said rocker members without producing stiffness of rocker action or a tendency to bind, and said plungers and the magnetic gap between said plungers is substantially centered between said spool ends; and thereafter rigidly fixing said sleeve to said sleeve members to lock them together.

7. A method for adjustably assembling parts of a relay having spool ends, sleeve members for carrying said ends and a sleeve spanning said members and for rigidly interlocking said members with said ends to form a rigid unit, a centrally disposed contact actuating rod, axially aligned magnetic plungers disposed in said spool between said ends on said actuating rod, a spacer on said actuating rod between said plungers, a pair of pins for interconnecting said plungers to prevent independent movements thereof and to subject them to counteraction one by another under shock or vibration, rocker members on said actuating rod for engaging the ends of said interconnecting pins, and pivotal mountings for said rocker members, which method of adjustably assembling said relay parts to eliminate looseness between said rockers and said interconnecting pins comprises; magnetically energizing said plungers to move them toward each other and against said spacer; then effecting relative movement of said pivotal mountings toward said rocker members until both ends of said interconnecting pins engage both of said rocker members without pressure and said plungers and the magnetic gap between said plungers is substantially centered between said spool ends; and thereafter tack welding said sleeve to said sleeve members.

8. In the assembly of an inaccessible counteracting mechanism totally surrounded by an enclosure made of magnetic material, said mechanism having first and second plungers of magnetic material, an actuating pin coupled to one of said plungers and normally reciprocable through the wall of said enclosure, said plungers being in magnetic relation to each other and to the walls of said enclosure and slidably operable on a four-sided, rockable, linkage having opposite sides formed of first and second pins and opposite ends formed of first and second rocker arms pivoted on opposite inner walls of said enclosure for engaging at their ends the ends of said pins, said first pin being fixedly attached to said first plunger and said second pin being fixedly attached to said second plunger, whereby a force tending to cause movement of the said plungers in the same direction will tend to rock the linkage in opposite directions, a method of adjusting said enclosed mechanism to eliminate loose interplay between said pins and said rocker arms without causing stiffness or a tendency to bind in the operation of said linkage, the said method comprising: applying a magnetic field to said enclosure to develop magnetic pull between said plungers sufficient to cause said plungers to slide together; while maintaining said magnetic field, applying sufficient pressure to the said opposite walls of the enclosure to move the said rocker arms toward the ends of said pins; and while maintaining said magnetic field and said plungers together, applying a reciprocatory force to the protruding end of said actuating pin in order to detect the presence or absence of loose interplay in the said linkage.

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