Aug. 7, 1962 K. PALMER ET AL 3,048,676

CONTACT MAKING DEVICES

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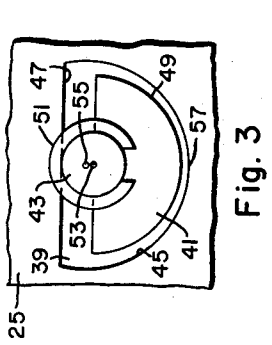


Fig. 3

Fig. 1

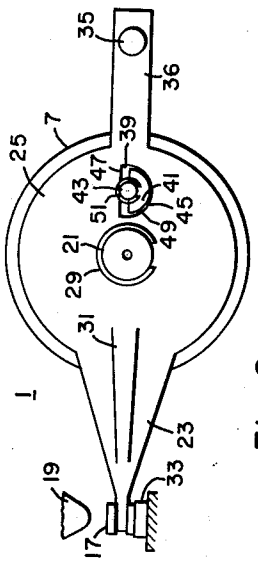


Fig. 2

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CONTACT MAKING DEVICES

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This invention relates to contact making devices, and it has particular relation to electroresponsive relays having relatively movable contacts.

One of the problems present in the operation of relatively movable contacts involves contact bounce. When a movable contact is actuated into engagement with a fixed contact, any tendency of the movable contact momentarily to disengage the fixed contact may interfere with proper control of a circuit associated with the contacts.

In an effort to overcome the effects of contact bounce, the prior art has mounted a stationary contact for limited movement, the contact being biased in a predetermined direction by means of a spring. Although the resultant "follow" action of the stationary contact is helpful for high operating torques, it does not eliminate contact bounce for low operating torques. For example, if the stationary contact is permitted to move for a distance of the order of .015 inch, the torque level at which non-bounce action is lost may be as high as fifty times the minimum pickup torque of the operating mechanism. This means that for torques between the minimum pickup torque and fifty times the minimum pickup torque, substantial bounce of the movable contact may be encountered.

In accordance with the invention, a movable contact is operated into engagement with a stationary contact through an energy-absorbing coupling. With such construction, the absorbed energy is no longer available to create contact bounce over a maximum range of closing force, i.e., from as low as one gram of closing force at the point of engagement between the contacts to over 250 grams of closing force. Preferably, the coupling is so configured that the amount of energy absorbed thereby gradually increases as the movable contact is operated into engagement with the stationary contact. The stationary contact is either of rigid construction or it may have a very small follow. The invention also contemplates the use of an energy-reflecting coupling to operate the movable contact out of engagement with the stationary contact. In addition, the moving contact assembly is designed to improve relay sensitivity and operating speed by minimizing weight of the assembly through the use of relatively thin stock for mounting the movable contact.

It is, therefore, an object of the invention to provide an improved contact making device.

It is a further object of the invention to provide a relay having a movable contact which is operated into engagement with a stationary contact through an energy-absorbing coupling.

It is another object of the invention to provide a relay as defined in the preceding paragraph in which the movable contact is disengaged from the stationary contact by means of an energy-reflecting coupling.

It is also an object of the invention to provide a relay having relatively movable contacts with improved sensitivity and increased operating speed.

Other objects of the invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a view in side elevation with parts broken away of a relay embodying the invention;

FIG. 2 is a view in top plan of the rotor structure and movable contact assembly employed in the relay of FIG. 1; and

FIG. 3 is an enlarged view of a portion of the rotor structure and movable contact assembly coupling means illustrated in FIG. 2.

Although the invention is applicable to various contact making devices, it is particularly suitable for relays having relatively movable contacts. For this reason the invention will be described as applied to a relay of the type illustrated in the copending patent application of Gino J. Marieni, Serial No. 677,639, filed August 12, 1957, now Patent No. 2,949,515, issued August 16, 1960 and assigned to the same assignee as the present patent application.

Referring to the drawing, FIG. 1 shows a relay having a rotor structure **1** which is associated with a stator structure **3**. The rotor structure **1** includes a shaft **5** on which is mounted a hub **7** constructed of suitable insulating material such as phenolic resin. An electroconductive armature **9** in the form of a hollow cylinder has one end secured to the hub **7** in any suitable manner.

The shaft **5** is mounted for rotation relative to the stator structure **3** by means of suitable bearings **11** and **13**, which form part of the stator structure. The stator structure includes windings **15** which may be energized to produce a rotating magnetic field which acts to produce a torque urging the armature **9** about its axis relative to the stator structure. The components of FIG. 1 which thus far have been specifically referred to may be similar in construction to the corresponding components of the aforesaid Marieni patent.

Rotation of the shaft **5** is employed for actuating a movable contact **17** into and out of engagement with a stationary contact **19**. To this end, the hub **7** is provided with a substantially cylindrical projection or boss **21**. If desired, the hub **7** and the boss **21** may be molded as a unit from suitable insulating material such as phenolic resin.

The movable contact **17** is secured to a one-piece mounting structure which comprises an arm **23** extending from a flat portion **25**. Conveniently, the mounting structure may be fabricated of electroconductive material such as aluminum or brass. The flat portion **25** is disposed on the hub **7** by means of an aperture **27**, through which the boss **21** projects. Conveniently, the boss **21** is provided with an annular groove into which is inserted a split retaining ring **29** to retain the mounting structure on the hub **7**. It will be appreciated that substantial rigidity of the mounting structure is obtained by placing the wide dimensions thereof in planes parallel to the plane of greatest stress between the movable contact **17** and the stationary contact **19**, that is, in planes transverse to the shaft **5**. Such a configuration minimizes the weight of the mounting structure by permitting the use of relatively thin stock therefor. In order to increase the rigidity of the arm, it may be provided with one or more ribs **31**.

A stop **33** secured to the stator structure **3** limits movement of the movable contact **17** in a counterclockwise direction, as viewed in FIG. 2. A counterweight **35** disposed on a projection **36** of the mounting structure flat portion **25** may be employed for balancing the mounting structure supporting the movable contact **17**.

The rotor structure **1** is biased in a counterclockwise direction, as viewed in FIG. 2, by means of a spiral control spring **37** which has its outer end secured to the stator structure and which has its inner end secured to the rotor structure in any suitable manner.

The flat portion **25** of the movable contact mounting structure has a second aperture **39** through which projects a flexible stop **41** and a rigid stop **43** from the hub **7**. By inspection of FIGS. 2 and 3, it will be observed that the aperture **39** has a circular wall portion **45** and

a straight or flat wall portion 47. The flexible stop 41, which is in engagement with the rigid stop 43, also has a circular wall portion 49, which is adjacent the circular wall portion 45 of the aperture 39. The stop 41 is fabricated of resilient or energy-absorbing material, such as vinyl plastic or silicone rubber, and is keyed into a recess in the hub 7 to prevent its turning. The stop 43, on the other hand, is constructed of energy-reflecting material such as steel and conveniently may be insert molded in the hub 7. The stop 41 may be retained in position by means of a split retaining ring 51, which is secured to the stop 43 by means of an annular groove therein.

As will be observed in FIG. 3, the circular wall portion 49 of the flexible stop 41 has a center of curvature, represented by a point 53, which is displaced from the center of curvature, represented by a point 55, of the circular wall portion 45 of the aperture 39 in the contact-engaging direction of rotation of the rotor structure 1. The purpose of this displacement will be pointed out below. Furthermore, the radius of curvature of the circular wall portion of the stop 41 is less than that of the circular wall portion of the aperture 39 by an amount sufficient to permit a small amount of relative rotation between the rotor structure 1 and the movable contact mounting structure, such as 1/64 inch. It will be observed that the spacing between the circular wall portion of the aperture 39 and the circular wall portion of the stop 41 gradually decreases, proceeding from each of the ends of the latter to the mid-point thereof.

Preferably, the stationary contact 19 is of rigid construction. However, if desired, the stationary contact may be spring-mounted in a conventional manner to permit a very small deflection thereof as the movable contact 17 is forced against the stationary contact. The movement of the stationary contact under these conditions preferably should not exceed about .006 inch, the preferred maximum movement being about .004 inch.

In operation, the movable contact 17 is held against the stop 33 by the bias developed by the control spring 37 or by a restraint torque or by both the bias and the restraint torque. Such a bias and a restraint torque are well known in the relay art. Under these conditions, the rigid stop 43 is held against the flat wall portion 47 of the aperture 39, the flexible stop 41 being spaced from the circular wall portion 45 thereof, and the mechanism is ready for a contact-making operation.

When the relay is to engage the contacts 17 and 19, the energy supplied to the windings 15 produces a torque urging the shaft 5 in a clockwise direction, as viewed in FIG. 2. As the hub 7 moves with the shaft relative to the movable contact mounting structure, the energy-absorbing stop 41 also moves therewith to occupy the space between it and the circular wall portion 45 of aperture 39. Continuation of such movement results in engagement of the circular wall portion of the energy-absorbing stop with the circular wall portion of the aperture at a point represented by the reference character 57 in FIG. 3 to terminate relative movement between the rotor structure and the movable contact mounting structure. Consequently, further movement of the stop 41 with the hub 7 effects actuation of the mounting structure of the movable contact 17 to move the contact 17 toward the stationary contact 19. Since, by virtue of the configuration of the flexible stop 41 and the aperture 39, the area of contact between the circular wall portions thereof gradually increases, proceeding in both directions from the point 57, the amount of energy absorbed by the stop 41 also gradually increases as the components continue to move in clockwise direction, as viewed in FIG. 2. When the movable contact 17 engages the stationary contact 19, the stop 41 cushions the impact by virtue of its energy absorbing characteristic, and the contact 17 comes to rest without bounce.

When the relay is to disengage the contacts 17 and 19, the aforesaid closing energy supplied to the windings 15 is removed. Under these conditions, the bias spring 37 or the bias spring and resetting energy supplied to the winding 15 act to produce a torque urging the shaft 5 in a counterclockwise direction, as viewed in FIG. 2. Since a space now exists between the energy-reflecting stop 43 and the flat wall portion 47 of the aperture 39, the rotor structure 1 and the stop 43 move relative to the movable contact mounting structure until the stop 43 engages the flat wall portion of the aperture. Thereafter, the rotor structure and the movable contact mounting structure rotate in unison to disengage the movable contact 17 and the fixed contact 19. Such movement continues until the mounting structure engages the stop 33. The rigid stop 43 and the flat wall portion of the aperture 39 coact to prevent any "kickback" from occurring. This is defined as a reclosing of the relay contacts after strong restraint torque is suddenly removed.

The resilient material from which the energy-absorbing stop 41 is fabricated has the desirable property of returning to its original shape when the contact closing force is removed, without returning so suddenly as to cause "rebound," i.e., contact reclosure after engagement of the movable contact mounting structure with the stop 33. This enables the contacts to operate equally well with or without the application of additional contact-resetting torque from energy supplied to the windings 15. The spacing between the circular wall portion 49 of the energy-absorbing stop 41 and the circular wall portion 45 of the aperture 39 desirably is held to a minimum to limit relative rotation between the rotor structure 1 and the movable contact mounting structure to a very small amount, thus avoiding any appreciable loss of contact closing or opening time due to slippage between the rotor structure and the movable contact mounting structure. Some spacing, however, is preferable in order to prevent, under wide variations of ambient temperature and humidity, permanent deformation of the energy-absorbing stop, in consequence of contact between the energy-absorbing stop and the aperture wall over long periods of contact-open time, and the resulting degradation of the energy-absorbing characteristic of the resilient stop.

Although the invention has been described with reference to certain specific embodiments thereof, numerous modifications falling within the spirit and scope of the invention are possible.

We claim as our invention:

1. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor structure into and out of engagement with the fixed contact, said mounting structure being rotatable relative to the rotor structure, and an energy-absorbing stop secured to one of said rotor and mounting structures for rotation therewith, said stop being adapted to engage the other of said rotor and mounting structures for actuating said movable contact as the rotor structure rotates about said axis in contact-engaging direction and to disengage said other structure as the rotor structure rotates about said axis in contact disengaging direction.

2. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor structure into and out of engagement with the fixed contact, said mounting structure being rotatable relative to the rotor structure, energy-absorbing means for coupling said mounting structure to said rotor structure to actuate said movable contact as the rotor structure rotates about said axis in contact-engaging direction, energy-reflecting means for coupling said mounting structure to said rotor structure to actuate said movable contact as the rotor structure

rotates about said axis in contact-disengaging direction, and stop means limiting movement of said movable contact when the rotor structure rotates about said axis in said contact-disengaging direction.

3. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor structure into and out of engagement with the fixed contact, said mounting structure being rotatable relative to the rotor structure, an energy-absorbing first stop and an energy-reflecting second stop, said stops being secured to one of said rotor and mounting structures for rotation therewith, said first stop being adapted to engage the other of said rotor and mounting structures for actuating said movable contact as the rotor structure rotates about said axis in contact-engaging direction, said second stop being adapted to engage said other structure for actuating said movable contact as the rotor structure rotates about said axis in contact-disengaging direction, and stop means limiting movement of said movable contact when the rotor structure rotates about said axis in said contact-disengaging direction.

4. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor structure into and out of engagement with the fixed contact, said mounting structure being rotatable relative to the rotor structure, an energy-absorbing first stop and an energy-reflecting second stop, said stops being secured to one of said rotor and mounting structures for rotation therewith, said first stop being adapted to engage the other of said rotor and mounting structures for actuating said movable contact as the rotor structure rotates about said axis in contact-engaging direction, said second stop being spaced from said other structure when the rotor structure rotates about said axis in said contact-engaging direction, said second stop being adapted to engage said other structure for actuating said movable contact as the rotor structure rotates about said axis in contact-disengaging direction, said first stop being spaced from said other structure during at least a portion of the rotation of said rotor structure about said axis in said contact-disengaging direction, and stop means limiting movement of said movable contact when the rotor structure rotates about said axis in said contact-disengaging direction.

5. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor sturcture into and out of engagement with the fixed contact, said mounting structure being rotatable relative to the rotor-structure, one of said rotor and mounting structures having an aperture therein, an energy-absorbing first stop and an energy-reflecting second stop, means mounting said stops in the other of said rotor and mounting structures for rotation therewith, said stops projecting through said aperture, said first stop being disposed to engage a first wall portion of said aperture for actuating said movable contact as the rotor structure rotates about said axis in contact-engaging direction, said second stop being disposed to engage a second wall portion of said aperture for actuating said movable contact as the rotor structure rotates about said axis in contact-disengaging direction, and stop means limiting movement of said movable contact when the rotor structure rotates about said axis in said contact-disengaging direction.

6. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor structure into and out of engagement with the fixed contact, said mounting structure being rotatable relative to the rotor structure, one of said rotor and mounting structures having an aperture therein, an energy-absorbing first stop and an energy-reflecting second stop, means mounting said stops in the other of said rotor and mounting structures for rotation therewith, said stops projecting through said aperture, said first stop being disposed to engage a first wall portion of said aperture for actuating said movable contact as the rotor structure rotates about said axis in contact-engaging direction, said first stop and said aperture first wall portion being so configured that the area of engagement therebetween gradually increases as the rotor structure rotates about said axis in said contact-engaging direction, said second stop being disposed to engage a second wall portion of said aperture for actuating said movable contact as the rotor structure rotates about said axis in contact-disengaging direction, and stop means limiting movement of said movable contact when the rotor structure rotates about said axis in said contact-disengaging direction.

7. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor structure into and out of engagement with the fixed contact, said mounting structure being rotatable relative to the rotor structure and having an aperture therein, said aperture having a circular first wall portion and a second wall portion, an energy-absorbing first stop and an energy-reflecting second stop, means mounting said stops in said rotor structure for rotation therewith, said stops projecting through said mounting structure aperture, said first stop having a circular wall portion whose center of curvature is displaced from that of said aperture first wall portion in contact-engaging direction of rotation of said rotor structure about said axis, said first stop circular wall portion being displaced to engage said aperture first wall portion for actuating said movable contact as the rotor structure rotates about said axis in said contact-engaging direction, said second stop being proportioned to be spaced from said mounting structure when the rotor structure rotates about said axis in said contact-engaging direction, said second stop being disposed to engage said aperture second wall portion for actuating said movable contact as the rotor structure rotates about said axis in contact-disengaging direction, said first stop being proportioned to be spaced from said mounting structure during at least a portion of the rotation of said rotor structure about said axis in said contact-disengaging direction, and stop means limiting movement of said movable contact when the rotor structure rotates about said axis in said contact-disengaging direction.

8. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor structure into and out of engagement with a fixed contact, said mounting structure being rotatable relative to the rotor structure and having width dimensions extending in planes transverse to said axis, an energy-absorbing first stop and an energy-reflecting second stop, said stops being secured to one of said rotor and mounting structures for rotation therewith, said first stop being adapted to engage the other of said rotor and mounting structures for actuating said movable contact as the rotor structure rotates about

said axis in contact-engaging direction, said second stop being adapted to engage said other structure for actuating said movable contact as the rotor structure rotates about said axis in contact-engaging direction, and stop means limiting movement of said movable contact when the rotor structure rotates about said axis in said contact-disengaging direction.

9. In a relay device for controlling an electrical circuit, a stator structure including a fixed electrical contact, a rotor structure mounted for rotation relative to the stator structure about an axis, a movable contact, a mounting structure mounting the movable contact on the rotor structure for actuation by the rotor structure into and out of engagement with the fixed contact, said mounting structure being rotatable relative to the rotor structure and having a flat body portion disposed on said rotor structure and an arm portion extending from said body portion, said body and arm portions having width dimensions extending in planes transverse to said axis, said movable contact being secured to said arm portion, said body portion having an aperture therein, said aperture having a circular first wall portion and a second wall portion, an energy-absorbing first stop and an energy-reflecting second stop, means mounting said stops in said rotor structure for rotation therewith, said stops projecting through said mounting structure aperture, said first stop having a circular wall portion whose center of curvature is displaced from that of said aperture first wall portion in contact-engaging direction of rotation of said rotor structure about said axis, said first stop circular wall portion being disposed to engage said aperture first wall portion for actuating said movable contact as the rotor structure rotates about said axis in said contact-engaging direction, said second stop being proportioned to be spaced from said mounting structure when the rotor structure rotates about said axis in said contact-engaging direction, said second stop being disposed to engage said aperture second wall portion for actuating said movable contact as the rotor structure rotates about said axis in contact-disengaging direction, said first stop being proportioned to be spaced from said mounting structure during at least a portion of the rotation of said rotor structure about said axis in said contact-disengaging direction, and stop means limiting movement of said movable contact when the rotor structure rotates about said axis in said contact-disengaging direction.

References Cited in the file of this patent

UNITED STATES PATENTS

1,400,126	Wutton	Dec. 13, 1921
1,823,252	Boedtcher	Sept. 15, 1931
2,766,357	Berg et al.	Oct. 9, 1956
2,794,887	Noyes	June 4, 1957
2,945,929	Calhoun et al.	July 19, 1960