

Feb. 4, 1969

R. P. HOLTGRETER
 ADJUSTING THE ARMATURE AIR GAP AND CHANGING THE
 STIFFNESS OF THE LOCK SPRING BY
 PLASTIC DEFORMATION
 Filed Jan. 4, 1966

3,425,119

FIG. 1

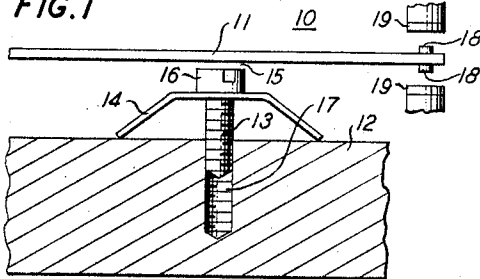


FIG. 2

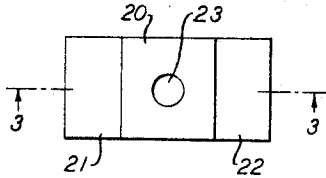


FIG. 3

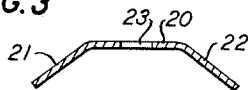


FIG. 4

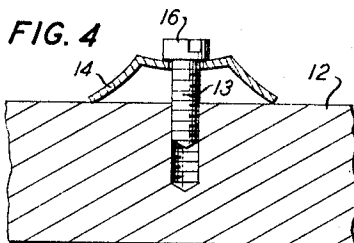


FIG. 5

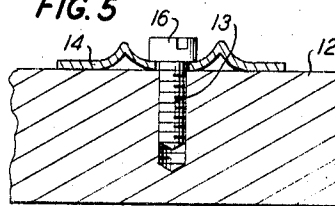


FIG. 6

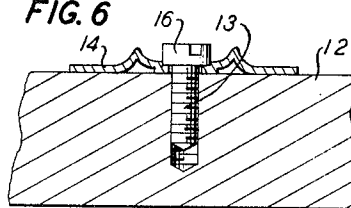
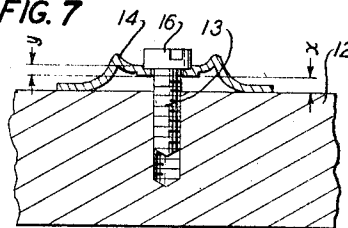


FIG. 7



INVENTOR
R. P. HOLTGRETER
 BY

Roger A. Clapp
 ATTORNEY

1

2

3,425,119

ADJUSTING THE ARMATURE AIR GAP AND CHANGING THE STIFFNESS OF THE LOCK SPRING BY PLASTIC DEFORMATION

Richard P. Holtfreter, Pickerington, Ohio, assignor to
Bell Telephone Laboratories, Incorporated, New York,
N.Y., a corporation of New York

Filed Jan. 4, 1966, Ser. No. 518,682

U.S. Cl. 29—593

3 Claims

Int. Cl. G01r 11/02; H01h 1/00; H01r 7/12

ABSTRACT OF THE DISCLOSURE

A method is disclosed for increasing the stiffness of a tripartite spring juxtaposed to a pole piece and an adjusting post in a relay during adjustment of the air gap between the adjusting post and the relay armature.

This invention relates to the adjustment of air gaps in relays and pertains particularly to air gap adjustments in relays in which the air gaps are located between an armature and an adjusting screw threaded into a pole piece.

It is an object of this invention to simplify the adjustment of the air gaps in such relays.

Relays in which this invention is particularly advantageous contain two contacts disposed on opposite sides of a magnetically responsive armature. Typically, the armature is mounted as a cantilever with one end fixed and the other end free to swing between the two contacts and two adjustment posts. The two adjusting posts are screwed into two pole pieces and are used to regulate the magnetic air gaps located between the adjusting posts and the armature.

In relays of the type described, it is important that the air gap adjusting mechanism exhibit two characteristics. First, it must be capable of precise but easy adjustment; and second, it must maintain the adjustment after having once been set. So far, attempts to meet these requirements have not met with complete success. In one typical arrangement, for example, the position of the gap setting adjusting post is maintained by a locking spring which has a middle section and two end sections. The middle section contains a hole for receiving the adjusting post while the two end sections are bent to angle away from the middle section in opposite directions.

When assembled in a relay, the locking spring is disposed between the adjusting post and the relay pole piece in such a manner that the two end sections rest on the pole piece and the middle section is tensioned against a shoulder on the adjusting post. The magnetic air gap between the adjusting post and the relay armature is then regulated by screwing the adjusting post into the pole piece against the tension of the locking spring. As the locking spring deflects, it generates a force which will hold the adjusting post in place when the proper air gap has been obtained.

In certain kinds of relays, however, space considerations require the locking spring to be rectangularly shaped. When this is the case, the middle section of the locking spring limits the amount of force which the locking spring as a whole can exert. Specifically, the hole in the middle section reduces the moment of inertia thereof to approximately half that of the two ends. Consequently, the ability of the middle section to resist bending forces is limited. In other words, because of the hole, it becomes so flexible that significant forces are only obtained when it is substantially deflected. Accordingly, the distance which the adjusting post can be screwed out of the pole piece and still be subject to appropriate spring forces is severely limited.

Heretofore, a flange bent at right angles to the middle section has been used to compensate for the flexibility caused by the hole. However, although the bent flange does increase the moment of inertia of the middle section and thereby increase spring stiffness, it requires extra spring material and extra manipulative steps in the manufacturing operation. In short, it increases the cost to make the locking spring.

It is therefore an object of this invention to achieve locking spring stiffness at low cost.

It is another object of this invention to simplify techniques for increasing locking spring stiffness.

According to one feature of this invention, the stiffness of a locking spring, having a middle section perforated by a hole and two ends bent to angle away from the middle section in opposite directions, is increased by inserting the locking spring under the head of an adjusting post and thereafter squeezing the locking spring with the head of the adjusting post until the portion of the locking spring surrounding the hole becomes permanently deformed.

In accordance with still another feature of this invention, the adjusting post squeezes the locking spring until the permanent deformation of the middle part thereof becomes large enough to increase the moment of inertia of the middle part to a value substantially equal to that of each of the two ends.

In accordance with one embodiment of this invention, an adjusting post and a locking spring are mounted between a pole piece and an armature in a relay; thereafter, the adjusting post is screwed into the pole piece until the locking spring is permanently deformed a predetermined amount, and finally, the adjusting post is unscrewed from the pole piece until it reaches a desired spacing from the armature where it is held by the deformed locking spring.

Other objects and features of this invention will become apparent upon a reading of the following detailed description when taken in conjunction with the drawing in which:

FIG. 1 is an elevation view of an adjusting post, a locking spring and portions of an armature and a pole piece assembled in a relay wherein all of the components are disposed in operative relationship to each other;

FIG. 2 is a plan view of a locking spring made in accordance with this invention;

FIG. 3 is a section view taken along line 2—2 of the locking spring shown in FIG. 2;

FIG. 4 is an elevation view of a locking spring mounted in an unstressed position between an adjusting post and a pole piece;

FIG. 5 is an elevation view of the locking spring shown in FIG. 4 being subjected to a stress by the adjusting post;

FIG. 6 is an elevation view of the locking spring shown in FIG. 4 and shows the locking spring depressed and permanently deformed a predetermined amount by the adjusting post; and

FIG. 7 is an elevation view of the locking spring shown in FIG. 4 after it has been deformed as shown in FIG. 6 and unscrewed a distance X from the pole piece.

Referring now to FIG. 1, a portion of a relay 10 is illustrated. The illustrated portion of the relay 10 comprises an armature 11, a pole piece 12, and adjusting post 13, and a spring 14.

The armature 11 is electrically conducting and magnetically responsive. As a consequence, it is made from an electrically conducting ferromagnetic material. One end (not shown) of the armature 11 is fixed while the other end is free to move toward the adjusting post 13, in response to the application of a magnetic flux. Furthermore, the free end of the armature 11 is separated from the adjusting post 13 by an air gap 15. In addition, the armature 11 includes two movable contacts 18 which

interact with two fixed contacts 19 when the armature 11 moves.

The pole piece 12 also conducts magnetic flux and is disposed magnetically in series with the armature 11. As a consequence, it too is made of a ferromagnetic material. One end thereof includes a tapped hole for receiving the adjusting post 13.

The adjusting post 13 is magnetically conducting and includes a head end 16 and a threaded end 17. The threaded end 17 is adapted to screw into the tapped hole in the pole piece 12 and the junction between the head end 16 and the threaded end 17 forms a shoulder for engaging a portion of the spring 14.

The spring 14 comprises a middle part 20 and two ends 21 and 22. The middle part 20 includes a hole 23 and the two ends 21 and 22 are bent to angle away from the middle part 20 in opposite directions. Conveniently, the spring 14 is made of sheet carbon steel.

As shown in FIG. 4, the spring 14 is assembled between the pole piece 12 and the head end 16 of the adjusting post 13. Thereafter, as shown in FIG. 5, the adjusting post 13 is screwed into the pole piece 12 until the middle part 20 bottoms against the pole piece 12. Next, as shown in FIG. 6, the head end 16 of the adjusting post 13 is screwed against the middle part 20 until permanent deformation occurs; viz., until the head end 16 presses a cup into the material of the middle part 20 around the hole 23. Finally, the adjusting post 13 is unscrewed from the pole piece 12 until it reaches a predetermined spacing from the armature (not shown).

The stiffness of the middle part 20 is directly proportional to its moment of inertia. The moment of inertia, in turn, is directly proportional to the thickness of the middle part 20. Deformation of the material around the hole 23, as shown by the dimension Y in FIG. 7, produces an effective increase in thickness of the middle part 20. As a result, the moment of inertia is increased when the middle part 20 is permanently deformed. In fact, the amount of increase can be precisely regulated merely by modifying the dimensions of the adjusting post 13 and the spring 14.

By this technique, therefore, the moment of inertia of the middle part 20 can be increased in a simple and effective manner. As a result, the stiffness of the middle part 20 is also readily increased, thereby increasing the stiffness of the entire spring 14 as well.

By deforming the spring 14 in the manner described, a large range of adjustment is achieved for the adjusting post 13. The limit of the range of adjustment for the adjusting post 13 is determined by the working distance of the spring 14. The working distance of the spring 14, in turn, is the distance over which it can be deflected and still continue to exert a sufficient force to prevent inadvertent movement of the adjusting post 13. Broadly, therefore, the stiffer the spring, the larger its working distance and the greater the range of adjustment possible for the adjusting post 13.

While there are no theoretical reasons why the working distance cannot be increased indefinitely, there are practical reasons why it cannot. When the spring becomes too stiff, an operator must exert so much torque that precise adjustment becomes virtually impossible. In certain relays, the adjustment must be made within a sixtieth of a revolution of the adjusting post. Where very high magnitudes of torque are required to turn the adjusting post, an adjustment this small becomes impossible.

The working distance of the spring 14 is designated by the X dimension shown in FIG. 7. If the distance X is exceeded, the force exerted by the spring 14 upon the adjusting post 13 will not be sufficient to prevent position changes due to external causes such as vibration or the like.

When a spring is made in accordance with this invention, a substantial increase in the distance X is obtained. For example, a fourfold increase is obtained from a

spring designed for use in the 280-type Bell System relay. That spring is rectangularly shaped and has a width of .375 inch, a thickness of .009 inch, and an overall length of .774 inch. The two ends are each .212 inch long and are bent to angle approximately 140° away from the middle part. The middle part is .350 inch long and has a centrally positioned hole having a diameter of .193 inch. The adjusting post is a screw having 4-32NC threads and a one-quarter inch diameter head.

When an assembler or other operator adjusts the air gap in the 280-type relay, he screws the adjusting post into the pole piece until the middle part of the spring bottoms against the pole piece. Thereafter, he continues to turn the adjusting post until he feels the material of the middle part give. At this point the elastic limit of the middle part has been exceeded, a permanent deformation has occurred and the middle part material surrounding the hole is flattened against the pole piece by the head of the adjusting post.

Further movement of the adjusting post can only be accomplished by exerting enough torque to make the spring material flow. The torque necessary to cause the spring material to flow however, is significantly greater than that required to cause it to give. Thus, the operator knows the proper spring deformation has occurred when he encounters a sudden increase in the adjusting post's resistance to turning.

The permanent deformation or cup pressed into the middle part of the spring by the adjusting post head produces an effective spring thickness of .0127 inch in the area around the hole. This thickness comprises the spring material thickness plus the depth of the cup; namely, the Y dimension shown in FIG. 7.

The Y dimension thickness of .0127 inch plus the .009 inch thickness of the undeformed remainder of the middle part of the spring combine to give the middle part a composite thickness which produces an increase in the moment of inertia. In fact, it turns out that the increase in the moment of inertia is just enough to give it a magnitude equal to that of the moment of inertia of either of the two identical ends.

Laboratory tests have shown that the biasing force of the spring decreases to approximately three pounds when the middle part is spaced .040 inch from the pole piece or, in other words, when the X dimension as shown in FIG. 6 is .040 inch. Three pounds is generally recognized as the minimum tolerable biasing force which can be used to hold the adjusting post in the 280-type relay.

Heretofore, the three pound minimum force was reached when the spring was spaced only .010 inch from the pole piece. Thus, by utilizing the teachings of this invention, a fourfold increase in the working distance of the spring has been obtained.

In summary, therefore, an arrangement for simplifying the setting of air gaps in relays has been described. Moreover, a simple and efficient apparatus for making the settings has been described as well. While these embodiments best represent the principles of this invention, may others within the scope of this invention will occur to those skilled in the art.

What is claimed is:

1. The method of positioning an adjusting post between a pole piece and an armature, said adjusting post including a head joined to a threaded shank by a spring engaging and deforming shoulder and being biased away from said pole piece and toward said armature by a spring having two ends resting on and extending away from said pole piece and a middle part joining said two ends, said middle part bearing on said adjusting post and having a shank accommodating aperture larger in diameter than said shank but smaller in diameter than said shoulder, comprising the steps of:

screwing said adjusting post into said pole piece a first distance, said first distance being traversed when said

5

6

middle part of said spring makes contact with said pole piece;

thereafter screwing said adjusting post into said pole piece a second distance beyond said first distance, said second distance being traversed when the shoulder on said adjusting post has plastically deformed a portion of said middle part of said spring and has flattened said portion of said middle part against said pole piece; and

thereafter unscrewing said adjusting post until said adjusting post is positioned between said pole piece and said armature in an operator determined spacing.

2. The method in accordance with claim 1 wherein the middle part deforms, when said second distance is traversed, an amount sufficient to effectively make the moment of inertia thereof substantially equal to the moment of inertia of one of said two ends.

3. In a method of adjusting the spacing between an armature and a pole piece having a first part and a second part, said first part including a shoulder and a shank adjustably joined to said second part, said first part being biased away from said second part and toward said armature by a spring having two ends resting on said second part and a middle, said middle including a shank accommodating aperture having a diameter large enough to accept said shank but smaller than the diameter of said shoulder, bearing on said first part and having a moment of inertia in longitudinal deflection less than the moment of inertia in longitudinal deflection of each end, the steps comprising:

moving said first part toward said second part a first distance, said first distance being traversed when the middle of said spring makes contact with said second part;

thereafter moving said first part toward said second part a second distance, said second distance being traversed when said shoulder on said first part has plastically deformed the middle of said spring beyond the elastic limit an amount sufficient to make the moment of inertia in longitudinal deflection substantially equal to the moment of inertia in longitudinal deflection of one of said ends; and

thereafter moving said first part until it is spaced between said second part and said armature in a predetermined position.

References Cited

UNITED STATES PATENTS

1,592,020	7/1926	Weston	-----	151—38
2,784,282	3/1957	Ramrath	-----	200—170

JOHN F. CAMPBELL, *Primary Examiner*.ROBERT W. CHURCH, *Assistant Examiner*.

U.S. Cl. X.R.

29—520, 622; 335—273; 151—38; 339—272; 200—166, 170