June 21, 1949. F. E. WOOD 2,473,982

ELECTROMAGNETIC RELAY

Filed Nov. 23, 1945

FIG. 1

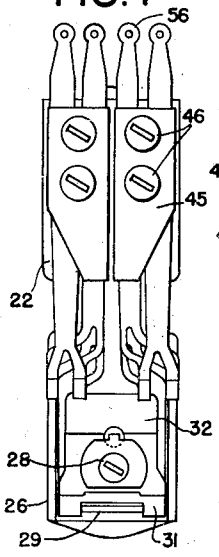


FIG. 2

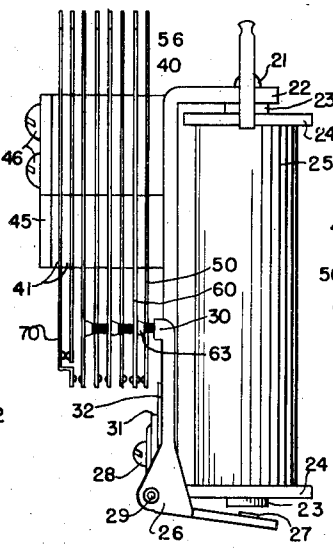


FIG. 3

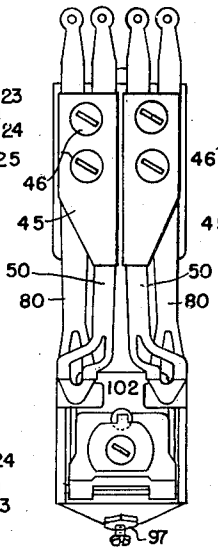


FIG. 4

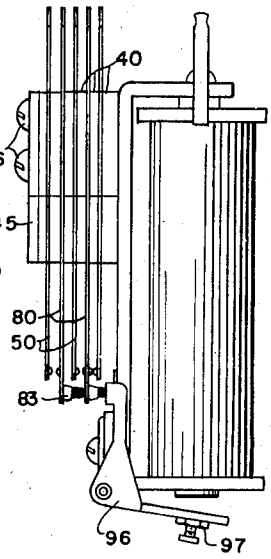


FIG. 5

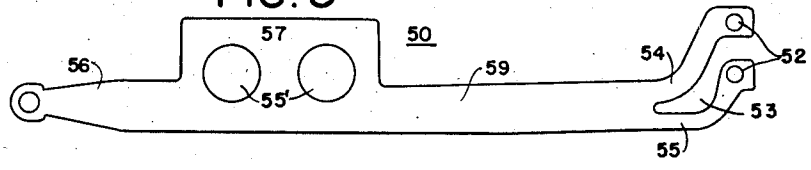


FIG. 6

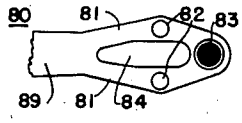


FIG. 8

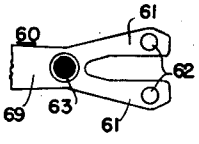


FIG. 10

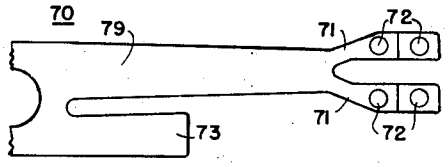


FIG. 7

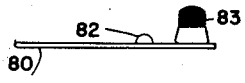


FIG. 9

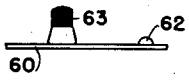


FIG. 11

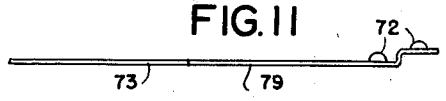


FIG. 12

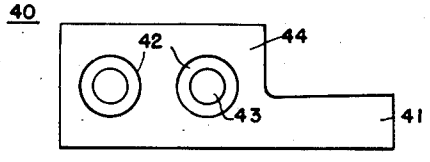
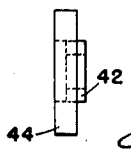


FIG. 13



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UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC RELAY

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Application November 23, 1945, Serial No. 630,421

3 Claims. (Cl. 200—1)

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The present invention relates in general to multi-contact relay switching devices and more particularly to the switching contact spring assembly controlled by the armature of an electromagnetic relay.

It is the main object of the present invention to provide an improved twin contact spring assembly for use on relays, such as commonly used in telephone or like systems.

When designing a twin contact spring assembly for a relay, it is necessary, in order to secure the best results, to have the two contacts of a spring close with approximately equal pressure to assure true twin contact action. This is most readily accomplished by having the movable springs and the stationary springs similar in shape and placed in superposed relation one above the other as is done in nearly all known commercial relays. When this practice is deviated from by placing the main body portion of one spring to the side of, or in non-superposed relation to, the main body portion of its adjacent spring in order to provide sufficient space to permit easy manual tensioning of the springs and proper position gauging of the contacts, then a contact extension arm is required on the free end of either one or both of the springs to properly align the cooperating contacts of the movable and stationary springs. In this case when the movable spring engages the contact extension arm of the stationary spring a torque action occurs, and in case the contact extension arm has twin contacts thereon then one contact has heavy contact pressure and the other twin contact has light contact pressure or none at all, thus defeating the main objective in a twin contact design.

One of the features of the invention is to provide a twin contact spring assembly having adjacent springs placed in non-superposed relation to permit easy adjustment and in which two independently flexible contact carrying arms extend from the free end of the stationary spring to align the twin contacts on the stationary spring with the contacts on the contact carrying branches of the movable spring, such independently flexible contact carrying arms of the stationary spring being designed to absorb the torque above mentioned and to give equal resistance to movement so as to equalize the contact pressure on the contacts on the branches of the movable spring. The movable spring also has two independently flexible branches for carrying the twin contacts of the movable spring so that if one of the two contacts engages before the other then the other flexible branch flexes independent of the first one to cause the second contact to engage its associated working contact.

In combination with the above the movable springs are each provided with a semi-rounded bushing secured near the contact carrying

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branches on the longitudinal center line of the movable spring so that each contact carrying branch of each movable spring can move, or flex, independent of the other branch in case a first one of the contacts on one of the contact carrying branches engages a contact on one of the arms of a stationary spring before the other contact on the other contact carrying branch engages a contact on the other arm of the stationary spring to assist in equalizing contact pressure and insure twin contact closure.

It is well known that when the relay armature is attracted to the relay core, the movable spring contacts strike the contacts of the stationary spring a sharp blow thereby causing the springs to vibrate at a frequency determined by its length and mass and with an amplitude determined by the striking force. The effect of the vibrations depends upon their amplitude, which may be enough to separate the contacts two or more times before the vibrations die out and the contacts remain closed thereby producing open circuit periods of short durations. These open circuit periods, known as "contact-bounce" or relay "chatter," often cause false operations which may be of a serious nature and should be eliminated or reduced to a point in which they are negligible.

Another feature of the present invention provides a simple and effective means for eliminating or reducing open circuit conditions due to "contact-bounce" to a negligible factor in the previously described improved twin contact spring assembly by extending the clamping base portion of only the stationary spring so as to provide a relatively short stiff portion extending from the clamping base and which short stiff portion has two independently flexible S-shaped arms extending from the free end thereof to align the contacts on such arms with the contacts on the movable spring. The two flexible arms are independently flexible with respect to each other and to the short stiff portion of the stationary spring and are of different length and mass so as to have different periodicities of vibrations and different amplitudes. Due to the extended clamping means for each stationary spring, the distance from the free end of the stationary spring to the clamping base is considerably shorter than the corresponding portion of the movable spring thereby providing a relatively short stiff portion having a different vibratory characteristic than the longer and more flexible movable spring. In the stationary spring the distance from the clamping base to its free end is relatively short with the result that the stationary spring as a whole will vibrate at a relatively high frequency having a relatively small amplitude thereby reducing the open circuit conditions, if any occur, to extremely short

durations of time. As previously described the twin contact carrying arms on the free end of the stationary spring are different in length and mass and therefore have different frequencies of vibration and amplitude when struck by the movable spring. During the vibratory periods of these twin contact arms on the stationary spring, one of the pair of twin contacts on one of the arms will vibrate at one frequency and amplitude while the other twin contact on the other arm will vibrate at a different frequency and amplitude, such two different frequencies being superimposed on the short stiff portion which vibrates at a third different frequency. The main body portion of the movable spring also vibrates at a frequency different from the short stiff portion of the stationary spring and the contact carrying branches of the movable spring vibrate in unison but at a different frequency than the main body portion. Due to the different vibratory characteristics of the twin arms, the short stiff portion of the stationary spring, the main body portion of the movable spring and the contact carrying branches, none of which vibrate in synchronism, one of the twin contacts on one of the arms may be in engagement with its working contact on the corresponding contact carrying branch of the movable spring while the other twin contact on the other arm of the stationary spring may be out of engagement with its working contact on the other corresponding contact carrying branch of the movable spring so as to maintain the circuit closed through at least one of the twin contacts, thereby reducing or eliminating open circuit conditions.

The invention will be more readily understood from the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 is a top or plan view of a relay having the improved spring assembly;

Fig. 2 is a side view of the relay shown in Fig. 1;

Fig. 3 is a top or plan view of a similar relay having a slightly modified improved spring assembly;

Fig. 4 is a side view of the relay shown in Fig. 3;

Fig. 5 shows an enlarged top view of one of the stationary springs;

Figs. 6 and 7 show partial top and side views, respectively, of the extremity of the free ends of the movable springs provided in the spring assembly shown in Figs. 3 and 4;

Figs. 8 and 9 show partial top and side views, respectively, of the extremity of the free ends of the movable springs provided in the spring assembly shown in Figs. 1 and 2;

Figs. 10 and 11 show partial top and side views, respectively, of a portion of the make-before-break spring shown in Figs. 1 and 2; and

Figs. 12 and 13 show top and end views, respectively, of the insulators used for separating the springs in the spring assemblies.

Referring now more particularly to Figs. 1 and 2 of the drawing, the electromagnetic relay comprises the usual field structure comprising the core **23**, winding **25**, the L-shaped heel piece **22** secured to the core **23** by means of screw **21** and the armature **26** which is pivotally secured to the heel piece **22** by means of the pivot pin **29**, yoke **31** and screw **28**. A bronze plate **32** is clamped between the yoke **31** and heel piece **22**. The armature **26** has a welded residual **27** to prevent the residual magnetism from maintaining the armature attracted after the winding **25** is de-energized. The armature has a turned over end **30** for engaging the semi-rounded bushing **63** secured to the first movable spring **60** in the spring assembly.

The spring assembly comprises a plurality of insulators **40**, stationary springs **50** and movable springs **60** and **70** secured to the heel piece **22** by means of screws **46** and metal top plates **45** as shown in the drawings.

Each stationary spring **50** comprises a terminal end **56**, a clamping base portion **57** provided with holes **55**, a main body portion **59**, S-shaped arms **54** and **55** with an S-shaped slot **53** between such arms, and a contact on each arm as shown in Fig. 5.

Each movable spring **60** has a similar terminal end and clamping base portion also provided with holes, a main body portion **69**, a semi-rounded bushing **63** secured on the longitudinal center line of the main body portion, two diverging contact carrying branches **61** and a contact **62** on each of the branches.

The base portions of the stationary springs **50** and the base portions of the movable springs **60** are assembled in superposed relation with an insulator **40** separating adjacent springs. The main body portions **59** of the stationary springs are assembled in superposed relation, the similar main body portions of the movable springs are also assembled in superposed relation but the main body portions **59** of the stationary springs are assembled in non-superposed relation to said similar main body portions of said movable springs, thereby aligning the main body portions of said movable and stationary springs in different parallel planes.

The insulators **40** are substantially L-shaped and each comprise a main base portion **44** and an extension **41**. Holes **43** are provided in the base portions **44** through which the screws **46** extend to secure the spring assembly to the heel piece. The insulators **40** have embossed lugs **42** which fit into the holes, such as holes **55'** of the stationary and movable springs to properly align the same. The extensions **41** are approximately one-half the overall length of the insulators and are provided to extend along only the main body portions **59** of the stationary springs so as to shorten the free end of each stationary springs so that its free end is approximately one-half the length the free ends of the movable springs. Each stationary spring **50** has its base portion **57** and part of its main body portion **59** clamped in the assembly to provide a relatively short stiff free end portion. Since the free ends of the stationary springs are relatively short and stiff as compared to the longer free ends of the movable springs, the free ends of the stationary springs have a natural frequency of vibration different from that of the longer free ends of the movable springs.

The S-shaped arms **54** and **55** are of unequal length and mass and are independently flexible with regard to the main body portion **59**. Since the S-shaped arms are of unequal length and mass these two arms each have different frequencies of vibration with respect to each other and the main body portion **59**. It should also be noted that the S-shaped arm **54**, where it joins the main body portion, is considerably wider than the width of arm **55** where it joins **59**. This difference in width of the two arms **54** and **55** has been carefully designed and tested to give equal

resistance to movement so as to equalize contact pressure when the contacts 62 of the movable springs engage the contacts 52 on arms 54 and 55.

The movable springs 60 have diverging branches 61 near the extremity of their free ends and each branch carries a contact 62 to cooperate with the associated contacts 52 on the S-shaped arms of the stationary springs. Bushing 63 comprises an insulating member secured in a metallic cup-shaped member which is welded on the center-line of the main body portion 69 near the extremity of the free end of the movable springs. The insulating member of bushing 63 has a semi-rounded surface so that the free end 69 may rock in case one of the contacts 62 engages a contact on one of the S-shaped arms 54 or 55 before the other contact 62 engages a corresponding contact. The diverging branches 61 are each independently flexible and are designed to give equal resistance to contact pressure.

The uppermost spring 70 is bent near its free end to form a make-before-break spring combination with its working movable spring 60 and its working stationary spring 50. The main body portion 79 of spring 70 is assembled in superposed relation with the main body portions 69 of the movable springs so as to align the spring in the same plane as the main body portions 69 of the movable springs. Branches 71 converge from the main body portion 79 and each branch 71 has a pair of contacts 72, one of which cooperates with a contact 52 on a stationary spring and the other which cooperates with a contact 62 on a movable spring. Spring 70 also has an extension 73 which is clamped between two extensions 41 of two insulators 40. Each movable spring also has an extension similar to extension 73 and these extensions are clamped in superposed relation with the extensions 41 on insulators 40 when the spring set is assembled.

The relay shown in Figs. 3 and 4 is similar in construction to the relay shown in Figs. 1 and 2 with slight modifications. The armature 96 has a shorter arm and the well-known type of screw residual 97. The spring assembly has the same type of stationary springs, such as stationary spring 50, but a slightly different movable spring 80. The movable springs 80, shown in part in Figs. 6 and 7, have a base portion, similar to the base portion 57, a main body portion 89, an extension similar to extension 73, two diverging branches 81 which carry the contacts 82, and a similar bushing 83 welded on the longitudinal center-line of the main body portion 89 at the extreme free end of each spring. The diverging branches 81 and the converging portions form a closed slot 84 and these branches 81 are independently flexible and are designed to give equal resistance to movement so as to equalize contact pressure. Insulators 40 also separate adjacent springs in the same manner as described for Figs. 1 and 2 to assemble the free ends 59 of the stationary springs in non-superposed relation to the free ends 89 of the movable springs.

Having described the construction and assembly of the relay, and pasticularly the improved cantilever contact spring assembly, the utility and purpose of the invention will be set forth to enable the invention to be more fully understood and appreciated.

As is well known, it is desirable to confine a relay mounting space to as small a space as is possible, and, therefore, the relays should be made large enough to perform the required functions and no larger. In designing contact spring assemblies for electromagnetic relays it is desirable to confine the spring assemblies within a certain limit which does not exceed the overall width of the magnetic structure of the relay. The usual method is to assemble both the movable springs and the stationary springs in superposed relation, one over the other, and, if a large number of switching contacts is desired, to provide the relay with two armature arms and two sets of spring assemblies, each operated by its corresponding armature arm. In spring assemblies of this type adjacent springs are usually too close to permit easy access for the required adjustments, such as tensioning the springs and proper position gauging of the contacts. Such adjustments are manually performed by duck-bill pliers or special tools and if sufficient space is not provided for these tools proper adjustments cannot be made. The preferred method to overcome this difficulty is to assemble the movable portions of the stationary springs in non-superposed relation with the movable portions of the movable springs thereby providing sufficient space between similar stationary and similar movable springs.

When the movable portions, or main body portions 59, of the stationary springs 50 are assembled in non-superposed relation with the movable portions, or main body portions 69 or 89 of the movable springs 60 or 80, extension contact carrying arms or contact carrying branches are needed to properly align the working contacts. The engagement of the contacts on these extension arms and branches causes a torque action in one or both springs and in case twin contacts are used on the arms and branches one of the contacts will have heavy contact pressure and the other twin contact will have light contact pressure or none at all unless some arrangement is provided to overcome this defect. In order to provide equalization of contact pressure on the twin contacts the springs are provided with independently flexible contact carrying arms and branches so that they may flex independently of each other. The contact carrying branches, such as 61 and 81, on the movable springs are each independently flexible and are designed to offer equal resistance to movement. The contact carrying arms 54 and 55 are S-shaped in order to align the contacts on such arms with the cooperating contacts on the branches of the corrsponding movable spring. As will be noted the S-shaped arm 54 is longer and wider than the S-shaped arm 55 in order to give equal resistance to movement and to overcome the torque action previously referred to. The twin contact carrying arms 54 and 55 of the stationary springs and the contact carrying branches 61, or 81, of movable springs 60 and 80 are purposedly designed to give true twin contact action and equalization of contact pressure. The S-shaped arms 54 and 55 and the contact carrying branches 61 and 81 are independently flexible and offer equal resistance to movement so that if one pair of cooperating contacts should engage before the other pair of cooperating contacts, then the branch carrying the other contact will be flexed while the first branch will be held to cause the other pair of cooperating contacts to engage, thus insuring twin circuit closures. The semi-rounded bushings 63 and 83 assist in insuring twin contact closures by permitting one branch to flex more than the other, if the other is in engagement with its associated working contact.

Practically all contact spring assemblies have

what is known as "contact-bounce" or relay "chatter." This "contact-bounce" or "chatter" is caused by the movable contacts striking the stationary contacts a sharp blow thereby causing the springs carrying such contacts to vibrate at a frequency determined by its length and mass and with an amplitude determined by the striking force. The amplitude of these vibrations may be enough to separate the contacts two or more times before the vibrations die out. These conditions produce open circuit periods of short durations which often cause false operations which may be of a serious nature and should be eliminated if possible.

In the present invention the open circuit conditions, due to "contact-bounce," have been entirely eliminated or have been reduced to a point where they no longer cause false operations. As will be noted the extensions **41** of the insulators **40** have been extended along only the main body portions **59** of the stationary spring **50** so that the movable portion, or free end, of the stationary spring comprises a relatively short stiff portion considerably shorter than the movable portion, or main body portions **69** or **89**, of the movable springs **60** and **80**. The short stiff portion of each stationary spring therefore has higher vibratory characteristics than the longer and more flexible movable springs. The free end of the stationary spring, as a whole, since it is short and stiff, will vibrate at a relatively high frequency and small amplitude thereby reducing the open circuit conditions to extremely short durations of time. The S-shaped arms **54** and **55** are of unequal length and mass and therefore have different frequencies of vibration and amplitude when struck by the movable spring and therefore vibrate at different frequencies. During the vibratory periods of the S-shaped arms and the free end of the stationary spring, one of the pair of twin contacts **52** on one of the arms will vibrate at one frequency and amplitude, the other twin contact on the other arm will vibrate at a different frequency while the short stiff portion will vibrate at a still different frequency. The main body portion of the movable spring also vibrates at a still different frequency while the contact carrying branches such as **61** or **81** vibrate in unison but at a frequency different than the frequency of the main body portion. Since none of these frequencies are in synchronism, one of the twin contacts on one of the S-shaped arms may be in engagement with its working contact on the corresponding contact carrying branch of the movable spring while the other twin contact on the other S-shaped arm of the stationary spring may be out of engagement with its working contact on the other corresponding contact carrying branch of the movable spring, so as to maintain the circuit closed through at least one of the twin contact pairs thereby eliminating or reducing open circuit conditions.

With all the above mentioned features combined in one relay it has been found that, with this spring assembly properly adjusted, and with the relay operating at a speed required in telephone systems, which does not exceed thirty-five pulses per second, that open circuit conditions caused by "contact-bounce" are entirely eliminated.

Having described the invention, what is considered new and desired to have protected by Letters Patent is specifically pointed out in the following claims.

What is claimed is:

1. In a twin contact cantilever spring assembly comprising movable springs and stationary springs of approximately the same overall length, each said spring having a clamping base portion and a free end extending endwise therefrom, means for clamping said base portions of said springs in superposed relation with the free ends of said stationary springs in one plane and with the free ends of said movable springs in a different plane, said clamping means including an L-shaped insulator separating said base portions, an extension on each insulator being approximately one-half that of the overall length of such insulator and extending endwise in only the same plane as the free ends of said stationary springs to reduce the length of the free ends of said stationary springs to that of approximately one-half that of the movable springs, said movable and stationary springs thereby having long and short flexing lengths, respectively, and are confined within a space extending endwise from and no wider than said clamping means to reduce the mounting space required for said springs, a pair of diverging branches on each movable spring near the extremity of its free end, a contact on each branch, a pair of S-shaped arms on each stationary spring near the extremity of its free end, each S-shaped arm extending from said one plane into the movable path of and into said different plane of said branches of the free ends of said movable springs, and a contact on each arm cooperating with a contact on a corresponding branch.

2. In a twin contact spring assembly comprising movable and stationary springs having common base portions and flexing portions extending endwise from said base portions, said base portions of said springs being arranged in superposed relation and the flexing portions of said movable springs being arranged in non-superposed relation with the flexing portions of said stationary springs, L-shaped insulators for separating and clamping said common base portions of all said springs to permit flexing of said movable springs the entire length of their flexing portions, an extension on each insulator extending endwise therefrom for clamping a portion of the flexing portion of said stationary springs to thereby shorten the flexing length of said stationary springs, said flexing portions of all said springs being confined within a space extending endwise from and no wider than said insulators to reduce the mounting space required for said springs, and S-shaped arms having contacts on each stationary spring for cooperation with corresponding contacts on said movable springs.

3. A twin contact spring assembly as claimed in claim 2 including an additional extension arm extending endwise from said common base portions of said movable springs and arranged in superposed relation with the clamped flexible portions of said stationary springs to build up an effective clamping means to permit flexing of only that portion of the stationary springs which extend endwise from said insulator extensions.

FREDRIC E. WOOD.

REFERENCES CITED

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

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Number	Name	Date
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