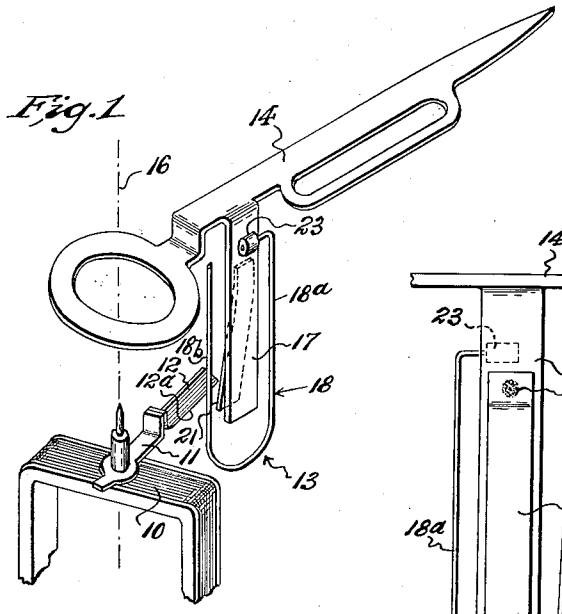
Sept. 26, 1961 E. M. EADIE, JR 3,002,074

RELAY CONTACT SYSTEM

Filed June 8, 1959

Fig. 1



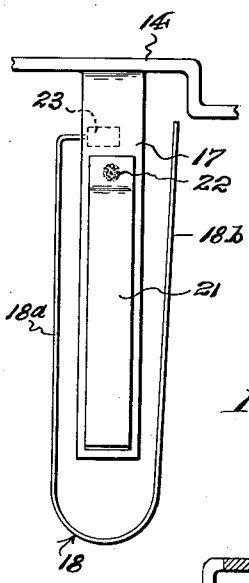


Fig. 2

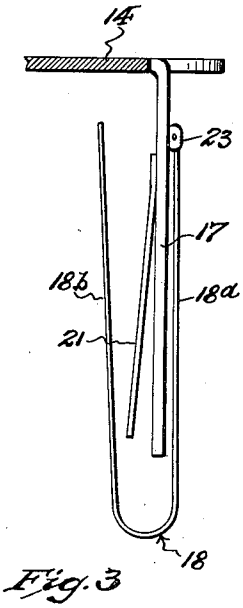


Fig. 3

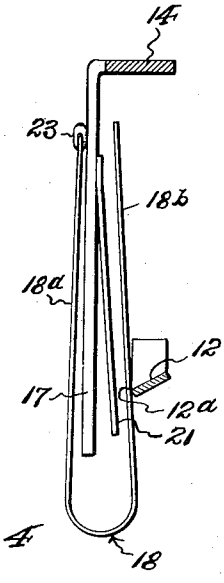


Fig. 4

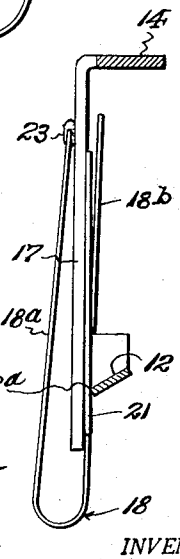


Fig. 5

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RELAY CONTACT SYSTEM

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This invention relates to highly sensitive relays and more particularly to a relay contact system for sensitive instrument type relays that develop relatively minute forces for effecting the contact engagement.

Electrical instrument type mechanisms having a high sensitivity develop only small mechanical forces which generally are not of sufficient magnitude to effect reliable engagement of relay circuit contacts associated with such mechanisms. Known systems for developing additional torque in the instrument moving system to insure reliable relay contact closure include the use of multiple contacts and a moving system having a pair of windings, one winding being adapted for connection to a small electrical output device, such as a photoelectric cell, thermocouple, and the like, to provide initial relay contact closure, and a second winding for aiding the relay contact closure following the initial relay contact closure. Such relays are referred to as load-current-contact-aiding type relays and are well known in the prior art. My invention relates to a relay contact system which is particularly suitable for use in low voltage, load-current-contact-aiding type relays. It will be understood, however, that the relay contact system is not limited to use in such load-current-contact-aiding relays but is of general use in any type relay desired.

An object of this invention is the provision of an improved contact system which provides good electrical contact with a minimum amount of contact pressure.

An object of this invention is the provision of a relay contact system which includes a pair of flexible contact members which successively engage a cooperating contact, which system includes a tube clamped to one relay contact member, and means welding the said tube to a metal member included in the system.

An object of this invention is the provision of a relay contact system including a flexible contact and a cooperating contact having a corner formed by the junction of adjacent wall portions of such contact, the flexible contact engaging the contact at the said junction with a scraping action to provide reliable contact engagement.

An object of this invention is the provision of a method of securing a non-ferrous contact member to a ferrous member comprising clamping the non-ferrous member in a hollow tube, and welding the tube to the ferrous member.

An object of this invention is the provision of a method of securing to a supporting member a contact of material such as gold, which material is subject to rapid amalgamation in soft solder and which would lose its desired hardness or spring properties in silver solder, which method comprises first clamping the contact in a tube of material suitable for spot welding and then spot welding the tube to the supporting member.

These and other objects and advantages will become apparent from the following description when taken with the accompanying drawings. It will be understood, however, that the drawings are for purposes of illustration and are not to be construed as defining the scope or limits of the invention, reference being had for the latter purpose to the appended claims.

In the drawings, wherein like reference characters denote like parts in the several views:

FIGURE 1 is a fragmentary perspective view of a relay including a contact system embodying the invention, but drawn to a greatly enlarged scale;

FIGURE 2 is a fragmentary side view of one contact member;

FIGURE 3 is a fragmentary edge view from the right of the contact member shown in FIGURE 2, with a part in section;

FIGURE 4 is a fragmentary edge view from the left of the contact member of FIGURE 2 of the system, showing the contacts in a stage of initial engagement; and

FIGURE 5 is similar to FIGURE 4 only showing the contacts in the final stage of engagement.

Reference is first made to FIGURE 1 of the drawings wherein reference numeral **10** identifies the coil element of the moving system of an instrument type relay which includes a magnetic system, not shown, having a magnetic flux gap in which the coil is supported for pivotal movement. The instrument is preferably of the well known load-current-contact-aiding type wherein the coil element comprises a pair of coil sections. An arm member **11** mounted on the coil **10**, and rotatable with the coil, carries a movable contact element **12** for cooperation with a relatively stationary contact designated generally by the reference numeral **13**. The contact **13** is mounted on an index arm **14** which is pivotally supported by means not shown about the pivot axis **16** of the moving coil **10**. The index arm **14** is manually angularly adjustable about the axis **16** by means not shown whereby closure of the contatcs may be effected at the desired magnitude of current through the coil **10**. It will be seen, then, that the contact **13** is not actually stationary but in use is only relatively stationary and is moved by adjustment of the index arm **14**. Any suitable means, not shown, may be employed to make an electrical circuit connection with the arms **11** and **14**.

The movable contact **13** comprises a base, or back-up strip, **17** integrally formed with the index arm **14** and made of stainless steel or other suitable electrically conductive material. A generally U-shaped wire **18** comprising generally parallel-extending leg portions **18***a* and **18***b* is attached by a novel attaching method and means, described in detail below, to the back-up strip **17** adjacent the index arm **14**. The wire **18** comprises one contact element of the novel contact system, and is preferably made of a highly conductive material such as a gold alloy, or other suitable material. The wire **18** is very flexible and is adapted to make initial contact with the contact element **12** upon rotation of the coil **10** in a clockwise direction about the axis **16**, as viewed in FIGURE 1. For a predetermined wire diameter, the length of the wire from the fixed end to the point of contact with the associated contact element **12** determines the magnitude of the spring action of the wire at such point of contact; i.e., the longer the wire is between such points, the weaker is the spring action. In order to obtain the desired flexibility, the wire **18** contacts the contact element **12** at the leg portion **18***b* removed from the fixed leg portion by the U-bend connection. A large degree of flexibility of the wire **18** is desired in order to obtain the desired amount of scraping action between the wire and contact element **12** upon closure of the contacts.

Reference is now made to FIGURES 2 and 3 of the drawings wherein it will be seen that a secondary contact element **21** is secured, as by welding **22**, or any other suitable means, to the back-up strip **17** adjacent the fixed end thereof. The secondary contact element **21** extends at a small acute angle with the back-up strip **17** in the open condition of the relay contacts. Such secondary contact element **21** is made from suitable contact material such as platinum-iridium alloy, or the like, which flexible whereby a small amount of scraping action is obtained between the contact elements **12** and **21** upon rela-

tive movement thereof when engaged. Both the contact elements **18** and **21** of the contact **13** are resilient and return to a normal predetermined position when the relay contacts are opened. The back-up strip, or base, **17** is relatively rigid and is not intended to flex or bend upon closure of the contacts.

As will be understood by those skilled in this art, it is extremely difficult to secure contact material, such as gold having a suitable hardness to provide the desired spring action, to a supporting member of ferrous metal, or the like. Soldering of the gold to the support, for example, is virtually impossible since the solder amalgamates very quickly with the gold. Even though gold has a melting temperature of about 1945° F., and soft solder a soldering temperature which rarely exceeds 600° F., it will be understood that as the solder amalgamates with the gold, the melting point of the gold is lowered to that of the soft solder, and soldering thereof is made impossible. If, on the other hand, one attempts to silver solder the gold to the support, to avoid the amalgamation action, the temperatures utilized in the soldering process destroy the desired spring properties of the gold. In the relay contact system of my invention, a novel method and means of securing the gold alloy contact element **18** to the back-up strip **17** is employed, which includes, as is seen in FIGURES 1 and 3, a tube **23** extending over the end of the contact element **18**, and clamped thereto. The tube is of a capillary size, having, by way of example, an outside diameter of 0.03" and in inside diameter of 0.01" in the undistorted shape. In making the connection, the tube is first placed over the end of the wire contact **18** (which may have a diameter of 0.006", for example) and is then flattened by any suitable means, to thereby clampingly engage the wire **18**. If desired, the tube may be crimped to the wire. The capillary size tube, which is made of stainless steel, or the like, is then welded to the stainless steel back-up strip **17** as by spot welding. It will be understood that both the tube **23** and contact element **21** may be spot welded to the stainless steel back-up strip **17** in the same welding operation, if desired. Further, the tube **23** may be secured to the same side of the back-up strip **17** as the contact element **21**, if desired. If this is done, the wire contact element **18** is provided with a slightly different shape whereby the leg portion **18***b* is positioned in substantially the plane shown despite the change in location of the fixed end thereof. Further, the clamping of the tube on the wire and the spot welding operation may be simultaneously performed since the spot welding function involves a clamping action. The only portion of the gold wire which may be adversely effected by the heat employed in the spot welding process is that portion clamped within the tube **23**; the effective portion of the gold contact wire outside of the clamping tube **23** being substantially unaffected by the welding heat. Thus, it will be understood that the welding process produces no deleterous effects on the contact arrangement.

Prior art relay contact systems include means for obtaining a wiping action of the contacts during the engagement thereof, which is intended to assure reliable contact closure when the relay has remained inoperative for a long period of time or when the relay is subject to conditions promoting the formation of high resistance films on the contact elements. It has been found, however, that a mere wiping contact engagement does not assure reliable contact closure, particularly under low contact force conditions. In the relay of my invention, such defects in the prior art relays are overcome by the provision of a scraping contact action whereby a reliable engagement of the contacts is secured.

Reference is made to FIGURE 4 of the drawings wherein the contact element **12** shown comprises a generally rectangular-shaped cross section whereby the adjacent plane surfaces of the contact form right-angular corners. The contact element **12**, which is substantially rigid and unyielding as compared to the flexible contact elements **18** and **21**, extends in a plane forming an angle with the contact elements **18***a* and **21** whereby the corner, designated **12***a*, comprises the contacting surface of the contact element **12**. The contact element **12** is preferably made of a material which is harder than the contact elements **18** and **21**, such material as rhodium, a rhodium alloy, or the like, being suitable.

Although the method of operation of the relay contact system is believed to be apparent, a brief description thereof follows. The initial contact engagement is made between the contact element **12** (at the relatively sharp corner **12***a* thereof) and the extremely flexible contact element **18** at the leg portion **18***a*. Since the contact element **18** is flexible, a scraping action occurs between the elements **12** and **18** as the element **18** is flexed after initial contact and upon further displacement of the relay moving system. The resultant scraping action between the relatively hard and sharp corner **12***a* of the contact element **12** and the soft, noble metal alloy contact element **18** provides a good electrical contact between the elements. By using a noble metal alloy, such as a gold alloy, for the contact **18**, the contact is sufficiently soft to insure a reliable engagement upon being scraped. Further, such noble metal alloy contact has a low resistivity and is corrosion resistant.

Upon initial engagement of the relay contacts, a current is fed therethrough to a coil winding to effect the further displacement of the moving system in a well known manner when the contact system is employed in a load-current-contact-aiding type relay. Displacement of the moving system will result in flexing of the contact element **18** and the above-described scraping action. After sufficient relative movement of the contact elements and flexing of the element **18**, the contact element **12** engages the contact element **21**. Since the element **21** is also flexible and is normally positioned a spaced distance from the back-up strip **17** at the free end thereof in the undeflected state, a small amount of scraping action takes place between the elements **12** and **21** as the element **21** is flexed from the position shown in FIGURE 4 into an abutting relation with the back-up strip **17** as shown in FIGURE 5. Reliable contact between the elements **12** and **21** is thereby assured. Since the contact pressure between contact elements **12** and **21** is much larger than between the elements **12** and **18**, a minimum scraping action is necessary to produce a reliable electrical connection therebetween.

By way of explanation, reliable initial electrical contact between the contact element **12** at the corner **12***a* thereof and the gold alloy contact element **18** is effected with less than one milligram force therebetween. By action of a suitable load-current-contact-aiding type relay mechanism, this extremely small initial contact force may provide the means whereby a contact force between the elements **12** and **21** of 2 grams may be achieved. It will be understood that in any load-current-contact-aiding type mechanism, some initial contact must be made before an improved contact may be effected. With the relay of my invention, it will be seen that an initial contact is established with extremely small forces necessary.

It will be noted that in the illustrated relay contact system, the free end **18***b* of the contact element **18** extends a substantial distance past the point of contact with the contact element **12**. With such a construction, the flexible contact **18** is substantially prevented from being caught behind the contact element **12** when the relay is subjected to vibration and shock. It will be understood that my invention is not limited to the use of such a long contact element **18** or even to a contact element **18** having a U-bend therein. It will be understood, then, that the contact element **18** may be shaped whereby the leg portion **18***a* thereof engages the contact element **12** whereby the U-bend and leg portion **18***b* are unnecessary and may be eliminated from the relay contact construction.

Having now described my invention in detail, in accordance with the patent statutes, various other changes and modifications will suggest themselves to those skilled in this art. It is intended that such changes and modifications shall fall within the spirit and scope of the invention as recited in the following claims.

I claim:

1. A sensitive relay type instrument comprising a back-up strip, an elongated first flexible contact element secured at one end thereof to the said back-up strip, a second flexible contact element secured to the back-up strip adjacent the secured end of the said first flexible member, the free end of the said second flexible contact element normally being spaced from the said back-up strip, a third contact element having a corner formed thereon which is adapted to successively engage the said first and second flexible contact elements upon relative movement of the said third contact element with the said first and second flexible contact elements, the first and second contact elements flexing under pressure exerted thereon by the third contact element to effect a scraping engagement between the corner on the said third contact element and the respective first and second flexible contact elements after initial contact engagement with the respective first and second flexible contact elements and upon relative movement of the engaged contacts, the said second flexible contact element being adapted to be flexed into abutting engagement with the said back-up strip by the said third contact element.

2. The invention as recited in claim 1 wherein the said first flexible contact element is made of a softer material than the said third contact element.

3. The invention as recited in claim 2 wherein the said first flexible contact element includes a U-bend between the secured end thereof and the area of contact engagement with the said third contact element.

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