July 5, 1966 H. N. WAGAR 3,259,715

LOCALLY BIASED REED SWITCHES

Filed July 22, 1964

FIG. 1

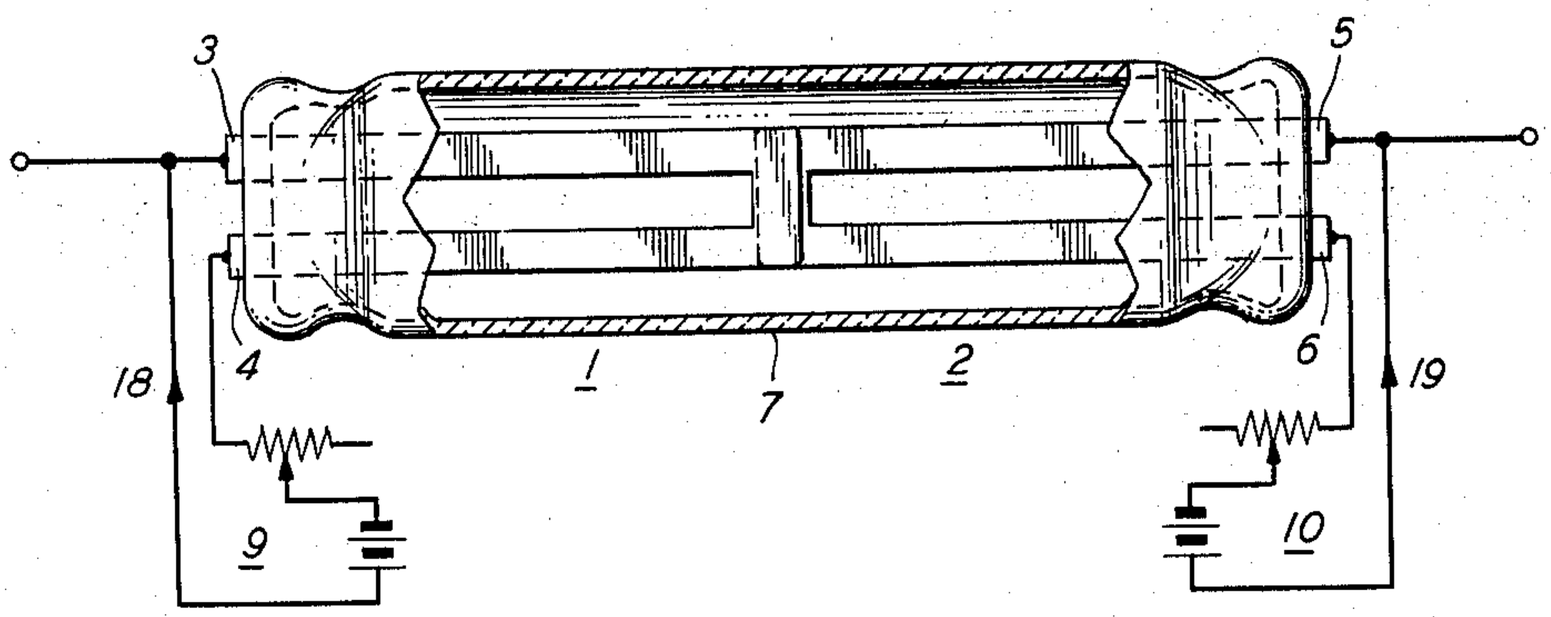


FIG. 2

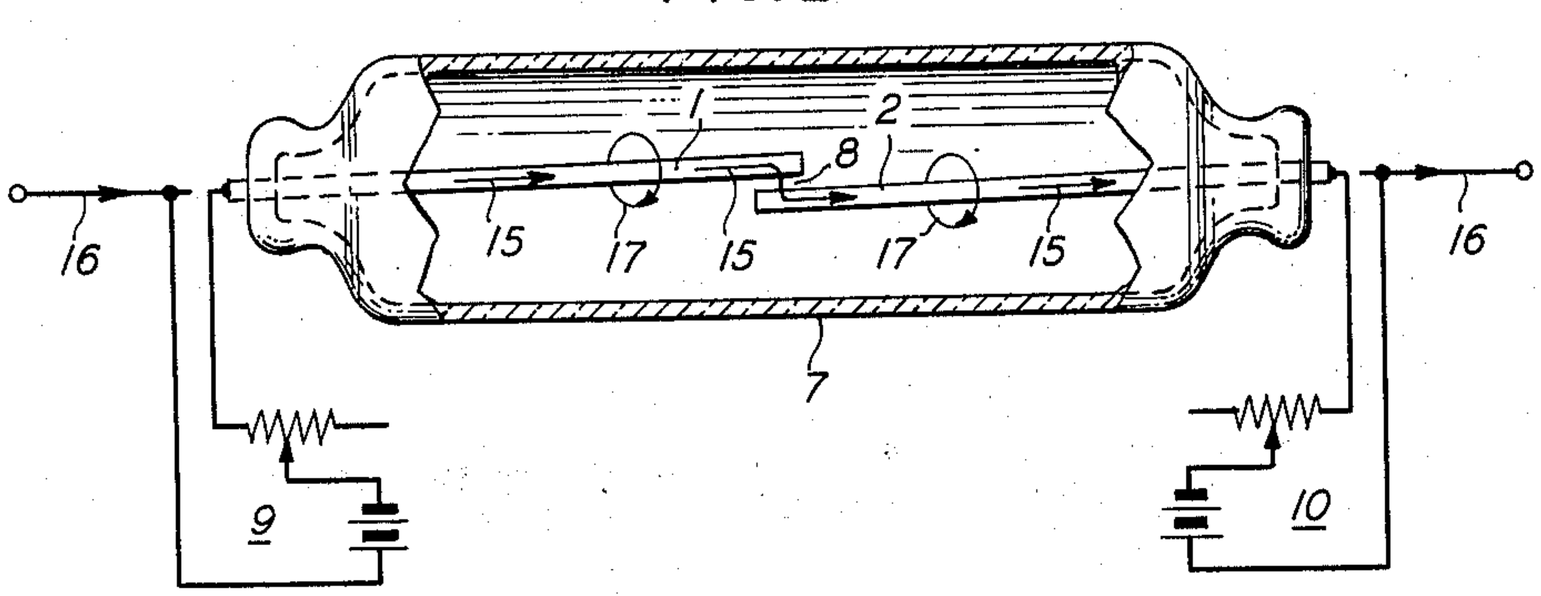
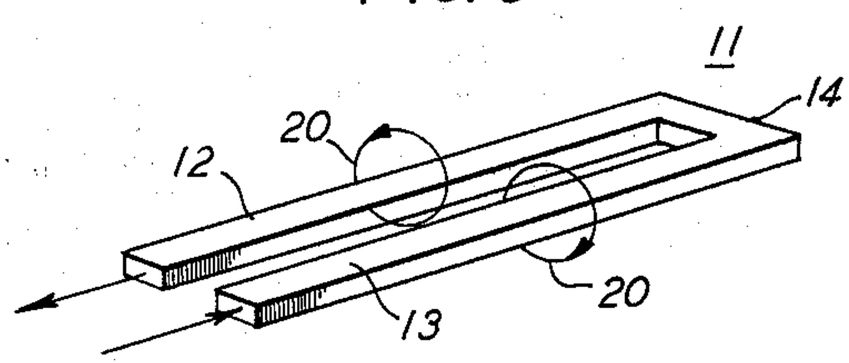


FIG. 3



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LOCALLY BIASED REED SWITCHES

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This invention relates to electromagnetic switching devices and in particular pertains to devices of the type called sealed contact reed switches.

Electromagnetic switching devices are characterized by the utilization of mechanical movement to close metallic contacts and thereby switch electrical currents. Such devices operate in response to energization of a magnetic field. A profusion of devices employing these characteristics are known and commercially available. One type, called the sealed contact reed switch, has acquired a particularly important place in the electromagnetic switching art.

The sealed contact reed switch was developed in order to obtain a switch having long contact life, low power requirements, and reliability, Basically, such a switch comprises two magnetic contacts or reeds sealed in a vessel as overlapping cantilevers wherein the tip of each is separated from the other by an air gap.

In operation, magnetic flux is passed serially or axially through the vessel and the reeds. As the axial flux passes along each reed and across the air gap separating their tips, a force of attraction is developed therebetween and the reeds move together until they touch. As a result, an electrically conducting path through the switch is established.

An operated reed switch can be opened or released by interacting a second magnetic flux with the axial or holding flux. When the two fluxes interact, the axial or holding flux is reduced until the force of attraction holding the reeds together is insufficient to withstand the restoring moment acting in each reed. As a result, the reeds separate and the switch opens.

In one known arrangement, the second flux is derived from the current flowing through the reeds. In this arrangement, the second flux is annularly disposed around the axial or holding flux.

Heretofore, control of reed release in switches opened by current derived flux could only be obtained by regulating the magnitude of the signal current passing through the reeds. While this method is suitable in many applications, it is not suitable where the circuit design requires a signal current having a constant magnitude.

It is, therefore, one object of this invention to control the operation of sealed contact reed switches.

Another object of this invention is to control the operation of sealed contact reed switches with the least number of components.

Another object of this invention is to control the opening and closing of contacts in a sealed contact reed switch without using opposing magnetic fluxes.

Still another object of this invention is to control the opening and closing of contacts in a sealed contact reed switch without modifying the principal current passing through the switch.

According to this invention, a control current and a signal current are applied together in at least one contact of a switch disposed in an axial magnetic flux.

According to one feature of this invention, a switch comprises two bifurcated, magnetic, flux-carrying contacts disposed in overlapping relationship. The furcations in each reed cooperate to establish a U-shaped path therein for conducting two independent currents. As a result, one current in each reed can be restricted to a loop including the furcations, while the other current therein can be passed from one reed to the other.

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Other objects, features, and novel aspects of this invention will become apparent upon consideration of the following detailed description taken in conjunction with the accompanying drawing wherein:

FIG. 1 is a plan view with parts broken away of a switch assembly constructed in accordance with the present invention;

FIG. 2 is an elevation view with parts broken away of a switch assembly constructed in accordance with this invention; and

FIG. 3 is a perspective view of a contact member.

The embodiment illustrated in FIG. 1 comprises two reeds or contact members **1** and **2**. The reed **1** is bifurcated to have furcations **3** and **4**. Similarly, the reed **2** is bifurcated to have furcations **5** and **6**.

The reeds **1** and **2** are substantially U-shaped and are made of a magnetic material. Moreover, as illustrated in FIG. 2, both reeds are sealed as overlapping cantilevers within an evacuated vessel **7** with their tips or bases separated by an air gap **8**.

An adjustable current source **9** is connected to the furcations **3** and **4**. In a similar manner, an adjustable current source **10** is connected to the furcations **5** and **6**.

FIG. 3 illustrates a typical reed or contact member **11** made U-shaped by two legs **12** and **13** interconnected by a cross member **14**.

In operation, an operating flux (from a source not shown and illustrated symbolically by the arrows **15** in FIG. 2) is passed axially or serially through the switch from one end to the other. As shown in FIG. 2, the flux **15** passes into and along reed **1**, through the air gap **8**, then along and out of the reed **2**.

As the magnetic flux **15** passes through the switch, the reeds **1** and **2** are attracted until they come together. When the reeds **1** and **2** touch, they establish an electrically conducting path through the switch and allow a main current represented by the arrows **16** to flow therethrough from a source not shown.

As the main current **16** flows from reed **1** through reed **2**, it develops an annular magnetic field, shown symbolically in FIG. 2 by the arrows **17**. As a result, an interaction occurs between the annular magnetic field **17** and the operating flux **15**. Therefore, the portion of the operating flux **15** holding the reeds **1** and **2** together is reduced. Furthermore, as force is proportional to the square of the flux, the amount of force between the reeds is also reduced.

Concurrently, a control current, as illustrated by the arrow **18** in FIG. 1, is introduced into the reed **1** from the current source **9** through one or the other of the furcations **3** and **4**. In a similar manner, a control current illustrated by the arrows **19** is introduced into one of the furcations **5** and **6** in the reed **2** from the current source **9**. Since each control current enters through one furcation and leaves through the other, a current loop is established in each of the reeds **1** and **2**.

Each control current develops an annular flux similar to that shown symbolically by the arrows **20** in FIG. 3. The annular flux developed by each control current interacts with the axial flux **15** in the same manner as the annular flux **17** developed by the main current **16**. As a result, a further reduction in the operating flux **15** occurs. As a further result, the force acting between the reeds is also reduced.

From the foregoing, it is clear that either of the control currents **18** or **19** or the main current **16** alone can be used to reduce the axial flux **15** and release the reeds **1** and **2**. Moreover, any combination thereof can be used. For example, the main current **16** can be held constant and release obtained by the control currents **18** and **19**.

It is to be noted that all of the control current flowing in each reed acts to reduce the axial flux **15**. In other words, even though the currents flowing in adjacent furcations of each reed are oppositely directed, the axial flux **15** in both is nevertheless reduced.

It is hypothesized that the reduction in axial flux is caused by shifting the magnetic domains of the magnetic reed material out of alignment with the principal direction of the axial flux. As a consequence, a net reduction of flux acting in the principal direction occurs regardless of whether the shift is to one side of the main axis of the principal direction or whether it is to the other side thereof. Therefore, while the action of the control current in each furcation rotates the domain direction to opposite sides of the main axis, the overall result in the bifurcated reed is nevertheless a reduction in the axial flux **15**.

Although two bifurcated reeds have been shown, it is readily apparent that one bifurcated reed combined with any conventional contact, reed or otherwise, will suffice equally as well. Moreover, it is clear that any type of magnetic contact can be bifurcated as well as a reed.

From the foregoing, it is readily apparent that various arrangements can be advantageously used to exploit this invention. Therefore, while one specific embodiment has been selected for detailed disclosure, the invention is not limited in its application to the embodiment disclosed. As a result, the embodiment which has been described should be taken as illustrative of the invention and its application rather than restrictive thereof.

What is claimed is:

1. In an electromagnetic switching device, the combination comprising:

a tipped pair of electrically conducting magnetic contacts disposed with their tips in overlapping relation, one of said contacts comprising means for conducting current in a loop including the overlapping tip of said one magnetic contact and for conducting current between said pair of magnetic contacts.

2. An electromagnetic device in accordance with claim **1** wherein each of said magnetic contacts comprises a reed member.

3. In an electromagnetic switching device, the combination comprising:

a vessel having sealed ends;

a tipped pair of contacts closable by magnetic flux sealed in said vessel with their tips overlapped and engaged, said pair of contacts including at least one bifurcated contact wherein each furcation thereof extends beyond a sealed end of said vessel;

a first electrical current passing through said contacts;

a magnetic flux passing serially through said contacts; and

an adjustable second electrical current flowing serially through the furcations of said bifurcated contact.

4. In an electromagnetic switching device, the combination comprising:

a pair of contact members disposed in overlapping relationship and engageable with each other in response to a magnetic flux passing serially therethrough, one of said contact members being U-shaped with the base of the U overlapping the remaining contact member and the legs of the U protruding from said vessel;

means for supplying magnetic flux serially to said pair of contact members; and

a source of electrical current connected across said legs of said one contact member.

5. In an electromagnetic switching device, the combination comprising:

a pair of magnetic contacts disposed in overlapping relationship and being closable in response to a serial magnetic flux, one of said contacts having a loop for confining a control current within said contact and for conducting current through said pair of magnetic contacts when said magnetic contacts are closed; and

means for supplying magnetic flux serially to said pair of magnetic contacts.

6. In an electromagnetic switching device, the combination comprising:

a tipped pair of magnetic contact members closable by a magnetic flux passing serially therethrough, said contact members disposed in overlapping relationship with their tips separated by an air gap, one of said magnetic contact members including two parallel legs interconnected by a cross member;

means for supplying a magnetic flux serially through said contact members and said air gap; and

means for supplying an adjustable current serially through said two parallel legs and said cross member.

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