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Bishop

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[54] **MAGNETIC REED CONTACT UNIT PRODUCING APPARATUS**

[75] Inventor: **William Dennis Bishop,** Beeston, England

[73] Assignee: **Plessey Handel Und Investments A.G.,** Zug, Switzerland

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[52] **U.S. Cl.** **29/622**

[51] **Int. Cl.** **H01h 11/00**

[58] **Field of Search** 65/155; 29/622, 593

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Primary Examiner—Charles W. Lanham
Assistant Examiner—Robert M. Rogers
Attorney—Blum, Moscovitz, Friedman & Kaplan

[57] **ABSTRACT**

Apparatus for, and methods of, producing magnetic reed contact units wherein a first contact member which is releasably held at one end thereof by support means, magnetically supports a second contact member at the other end thereof such that the ends of the contact members are overlapping and the longitudinal axes thereof are in alignment, the alignment being maintained during subsequent stages of the production method by a magnetic field established in or in the vicinity of the second contact member, wherein a double open-ended enclosure member is passed over the contact members, the means for establishing the aligning magnetic field being de-energised and removed to facilitate this operation, and wherein the aligned contact members are sealed within the enclosure member such that end portions thereof are overlapping and separated from each other by a desired amount.

5 Claims, 5 Drawing Figures

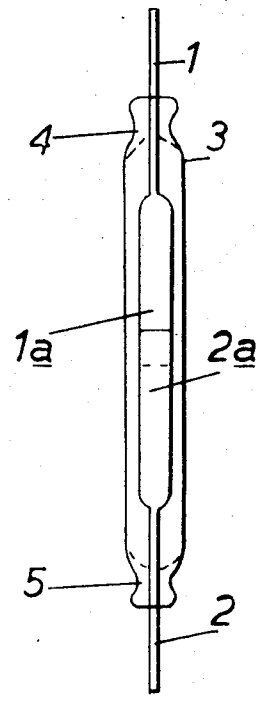


FIG.1a

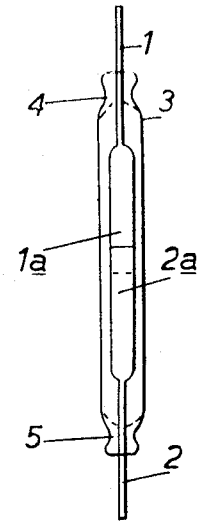


FIG.1b

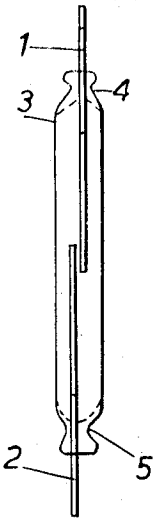
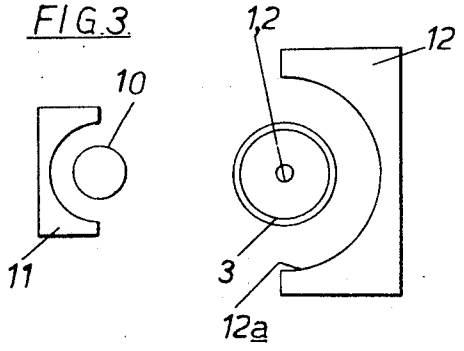


FIG.3



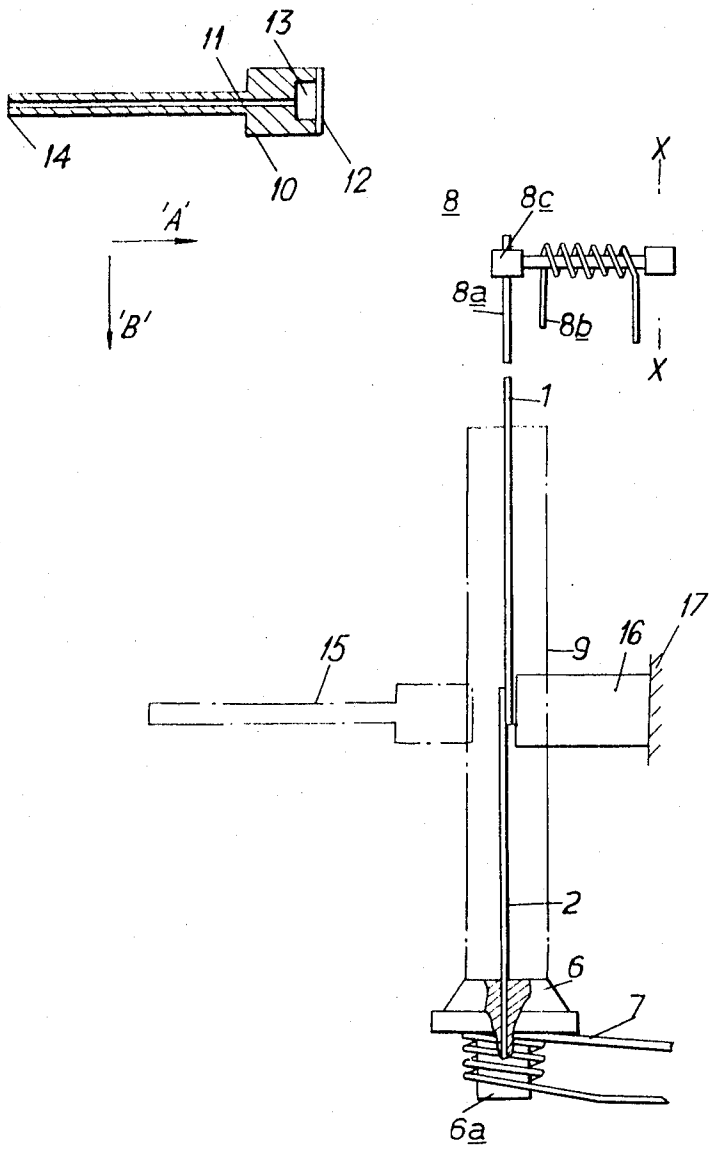


FIG.2a

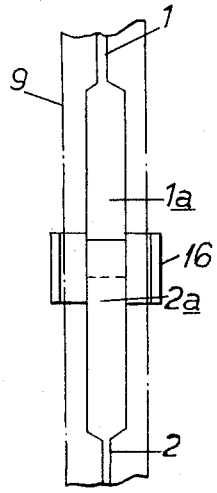


FIG.2b.

MAGNETIC REED CONTACT UNIT PRODUCING APPARATUS

The invention relates to methods of producing magnetic reed contact units, and to apparatus for the production of these contact units. Magnetic reed contact units of this type comprise at least two elongated electrical contact members which each have a blade or flattened portion at one end thereof, and which are each mounted within an enclosure member, preferably of glass, in a manner such that the flattened portions are overlapping, the contact members are substantially in alignment, and the other end of each contact member is retained by and extends beyond a separate one of the ends of the enclosure member. The overlapping ends of the contact members are normally separated from each other by a fixed predetermined amount and the arrangement is such that when the contact members, which are of a magnetic material such as nickel/iron alloy, and coated in the overlapping region with a material such as gold, are subjected to a magnetic field of sufficient intensity, the magnetic attraction between the overlapping ends causes them to be attracted to each other and thereby to make contact and establish electrical continuity between the two electrical contact members. The sealed enclosure member is usually filled with an inert or reducing gas or a mixture of both.

Known methods of producing magnetic reed contact units of the kind hereinbefore referred to include the steps of passing a double open-ended enclosure member over the contact members whilst one contact member is magnetically supported from the other contact member; sealing the magnetically supported contact member to the enclosure member; and sealing the said other contact member in the enclosure member after the desired separation distance has been established between the overlapping ends of the contact members. In general, the filling gas, when utilised, is introduced into the enclosure member prior to the sealing of the said other contact member to the enclosure member.

During various steps of the known methods and at various stages of the apparatus that is utilised for putting the methods into effect, the contact members can become misaligned due to movement of the magnetically supported contact member that is caused by the indexing operations which are effected between and during the various steps. Misaligned contact members in a completed magnetic reed contact unit can have detrimental effects on its operating characteristics therefore it is desirable to be able to maintain contact member alignment during magnetic reed contact unit production.

The invention provides a method of producing magnetic reed contact units of the kind hereinbefore referred to, including the steps of supporting one end of a first contact member from a support means such that the longitudinal axis of the contact member lies in a vertical plane; supporting a second contact member magnetically from the other end of the first contact member such that the ends of the contact members are overlapping and the axes thereof are in substantial alignment; establishing a magnetic field in or in the vicinity of the second contact member for maintaining the second contact member in alignment with the first contact member during subsequent steps of the method; passing a double open-ended enclosure member of a fusible material over the contact members, the

means for establishing the magnetic field being de-energised and removed during this step to facilitate the fitting of the enclosure member; sealing the magnetically supported and magnetically aligned second contact member to the enclosure member; releasing the magnetic support between the first and second contact members and the aligning magnetic field, the second contact member being supported by the enclosure member; causing relative movement between the first and second contact members to provide a desired separation distance between the overlapping ends of the contact members; and sealing the first contact member to the enclosure member whilst the contact members are in the separated condition.

The invention also provides an apparatus for the production of a magnetic reed contact unit of the kind hereinbefore referred to, including first support means for releasably supporting a first contact member, the longitudinal axis of the first contact member lying in a vertical plane; first magnetic field producing means for establishing, in or in the vicinity of the first contact member, a first magnetic field which facilitates the supporting of a second contact member from the first contact member such that the flattened ends are overlapping and the longitudinal axes thereof are in substantial alignment; second magnetic field producing means for establishing, in or in the vicinity of the second contact member, a second magnetic field which maintains the second contact member in alignment with the first contact member during various operations of the apparatus; loading means for passing a double open-ended enclosure member of a fusible material over the contact members, the second magnetic field producing means being de-energisable and movable to facilitate the loading; second support means for holding the enclosure member in position relative to the said contact members; first sealing means for sealing the magnetically supported and magnetically aligned second contact member to the enclosure member; adjusting means for causing relative movement between the first and second support means to facilitate the obtaining of the predetermined separation distance between the overlapping ends of the contact members, the first and second magnetic field producing means being de-energisable to facilitate the adjustment; and second sealing means for sealing the first contact member to the enclosure member whilst the overlapping ends of the contact members are in the separated condition.

The foregoing and other features according to the invention will be better understood from the following description with reference to the accompanying drawings, in which:

FIGS. 1*a* and 1*b* respectively diagrammatically illustrate a front view and a side elevation of a magnetic reed contact unit of the kind hereinbefore referred to,

FIGS. 2*a* and 2*b* respectively diagrammatically illustrate a partly sectioned side elevation and a part front view of part of an apparatus for the production of the magnetic reed contact units according to FIGS. 1*a* and 1*b* and

FIG. 3 diagrammatically illustrates a plan view of another part of an apparatus for the production of the reed contact units according to FIGS. 1*a* and 1*b*.

The magnetic reed contact unit diagrammatically illustrated in FIGS. 1*a* and 1*b* of the drawings is of the kind hereinbefore referred to in that it comprises two elongated electrical contact members 1 and 2 which

are each sealed within an enclosure member 3, preferably of glass, at those points indicated by the references 4 and 5. The contact members 1 and 2 are made of a soft magentic material, such as a nickel/iron alloy, and the ends 1*a* and 2*a* are flattened and arranged such that they overlap as illustrated in FIG. 1*b*. The flattened ends 1*a* and 2*a* which are coated with a contact material such as gold, are, as illustrated in FIG. 1*b*, normally separated from each other by a fixed predetermined amount, the ultimate characteristics and performance of the reed contact unit being very largely dependent upon this spacing. The sealed enclosure member 3 can be filled with an inert or reducing gas or a mixture of both when the unit is being produced.

As previously stated the overlapping ends 1*a* and 2*a* can be brought together and thereby into contact with each other by the action of a magnetic force therefore the material from which the contact members are made must be sufficiently compliant to facilitate this movement, during the operating life of the unit. The operating magnetic force can, in practice, be provided by any suitable means, and in particular, the reed contact unit can be surrounded by a coil which when energised will produce the field sufficient to operate the contact members.

The magnetic reed contact unit according to FIGS. 1*a* and 1*b* can be produced by a method which includes the steps of supporting one of the contact members for example the contact member 2 such that its longitudinal axis lies in a vertical plane and its flattened end is uppermost, and supporting the other contact member i.e. in the given example contact member 1, magnetically from the contact member 2 such that the longitudinal axes of the two contact members are in substantial alignment, and the flattened ends 1*a* and 2*a* overlap by a desired amount.

A double open-ended enclosure member i.e., the member 3 of FIG. 1 is then passed over the two contact members 1 and 2 and held in position relative thereto. The magnetically supported contact member 1 is then sealed to the enclosure member i.e., the seal 4 is formed, after which the magnetic force between the two contact members is removed, the contact member 1 being maintained relative to the contact member 2 by means of the supported enclosure member 3.

In order to set the desired spacing between the overlapping ends 1*a* and 2*a*, the enclosure member support and the supported contact member 2 are moved relative to each other by the desired amount. The seal 5 is then formed which effectively seals the contact member 2 to the enclosure member 3 and the magnetic reed contact unit of FIGS. 1*a* and 1*b* is completed. When it is desired to fill the enclosure member with a gas, this is effected prior to the forming of the seal 5.

The nature of the apparatus which is utilised for producing the magnetic reed contact units in the manner specified in preceding paragraphs will depend on whether the machine is to be fully automatic or semi-automatic. For fully automatic operation an apparatus can be used, which has successive stations at which it dwells, and at each or some of which, one or more of the above-mentioned steps are carried out. In a semi-automatic apparatus the loading of the various parts of the contact unit and the positioning and sealing is effected at one station.

Whilst the apparatus to be subsequently outlined can be used in either a fully automatic or semi-automatic mode of operation, it is more adaptable to the fully automatic mode of operation.

Referring to FIGS. 2*a* and 2*b* of the drawings, that part of an apparatus according to the invention which is diagrammatically illustrated therein includes a collet arrangement 6 which is utilised to support the contact member 2 i.e., the first contact member which is loaded into the apparatus by means not illustrated, in the correct orientation, and which facilitates the magnetic supporting of the contact member 1 to the contact member 2. The magnetic support facility is provided by a coil 7 which surrounds a section 6*a* of the collet 6 which is of a magnetic material. When the coil 7 is energised it causes a magnetic field to be produced in the collet 6 and the contact member 2 and when the contact member 1 is brought into contact with contact member 2 during the assembly operation it is retained in position by this magnetic field. The arrangement (not illustrated) for loading and for positioning the contact member 1 relative to the contact member 2 which may be at the same station at which the contact member was loaded or at a subsequent station to which the apparatus has been indexed, is arranged such that the two contact members are in substantial alignment and overlap by the desired amount.

During subsequent operations of the apparatus which are performed at various other stations thereof, the two contact members 1 and 2 may become misaligned due to movement of the magnetically supported contact member 2 that is caused by the indexing operations which are effected between and at successive stations of the apparatus therefore it is necessary to provide some means of maintaining the alignment since misaligned contact members in a completed contact unit can have detrimental effects on its operating characteristics.

The unit indicated generally in FIG. 2*a* by the reference number 8 can be utilised to maintain the two contact members 1 and 2 in alignment during the indexing stages. The unit 8 includes a pin 8*a* of a soft magnetic material which is magnetically coupled to an electric coil 8*b* by means of a magnetic member 8*c*. The member 8*c* is pivotable about an axis 'X—X' such that it can be moved out of alignment with the contacts 1 and 2 by means not illustrated in order to facilitate, in a manner to be subsequently outlined, the carrying out of various stages of the production method. The pin 8*a* will be aligned with the contact members 1 and 2 after the contact member 1 has been loaded into the apparatus, and the coil 8*b* will be energised. This will cause a magnetic field to pass through the member 8*c* and the pin 8*a* and through the contact members thereby maintaining them in alignment. The pin 8*a* is, as can be seen from FIG. 2*a*, situated in close proximity to, but separated from the end of, the contact member 1 and the strength of the axial magnetic field emanating from the pin 8*a* is arranged in conjunction with the air gap separation in a manner such that it is sufficient to maintain the alignment during the indexing operation but insufficient to magnetically attract the top contact member 1 to the pin 8*a*. It will of course be appreciated that the magnetic field is arranged such that the adjacent ends of the pin 8*a* and contact member 1 are of opposite magnetic polarities. After indexing the apparatus to the station whereat the double open-ended enclosure member, indicated in FIGS. 2*a* and 2*b* by the chain dotted line 9, is passed over the two contact members and

held in the illustrated position by means not illustrated, the coil **8***b* is de-energised and the unit **8** pivoted about the axis 'X—X' to a position whereat it allows this loading operation to be effected.

The loading of the enclosure member **9** over the two contact members **1** and **2** is effected by a loading member **10** which is shown in FIG. **2***a* in section, and which is movable in suitably arranged guides in a plane normal to the longitudinal axes of the contact members **1** and **2**, and independently in a plane parallel to the longitudinal axes of the contact members **1** and **2**.

The loading member **10** has a central through bore **11** which is enlarged at one end **12** of the member **10** to provide a cavity **13**. The end **12** of the loading member **10** is shaped to conform to the periphery of the enclosure member and the end **14** is connected by means of a flexible coupling (not illustrated) to a source of vacuum. Application of the vacuum source causes the enclosure member to be secured to the end **12** of the loading member **10**.

Thus, in operation, the member **10** would, prior to the loading operation, be in the illustrated position and in this position an enclosure member feed mechanism (not illustrated) causes an enclosure member to be positioned relative to the end **12** of the loading member **10** at the instant the vacuum source is applied. The applied vacuum causes the enclosure member to be securely held to the end **12** such that its longitudinal axis lies in a vertical plane. The member **10** is then moved in the direction of the arrow 'A'. This movement causes the coil **8***b* to be de-energised and the unit **8** to be pivoted about the axis 'X—X' and moved to a position whereat it allows the loading of the enclosure member to be effected.

The movement in the direction of the arrow 'A' ceases when the longitudinal axes of the contact members are concentric with the enclosure member. The loading member **10** is then moved in the direction of the arrow 'B' thereby causing the enclosure member to be passed over the contact members **1** and **2**. The movement in the direction of the arrow 'B' ceases when the loading member **10** and the enclosure member are in those positions respectively indicated by the chain dotted lines **15** and **9**.

In this position a support member **16** which is secured to the frame **17** of the apparatus causes the enclosure member to be held in position relative to the contact members **1** and **2**. When the enclosure member is securely held by the support member **16**, the vacuum source is disconnected and the loading member **10** is moved in a direction opposite to the direction of the arrow 'A' until it is fully withdrawn. Withdrawal of the member **10** causes the unit **8** to be moved back to the illustrated position and the coil **8***b* to be energised in order to maintain alignment of the contact member **1** during subsequent operations. The member **10** is then moved in a direction opposite to the direction of the arrow 'B' until it is again in the illustrated position and ready to perform the next loading operation.

After the enclosure member has been loaded into the apparatus, the soft magnetic pin **8***a* is again brought into alignment with the contact member **1** and **2** in order to maintain them in alignment during subsequent indexing operations.

The seal **4** is then formed by means not illustrated in FIG. **2** at another station of the apparatus thereby securing the contact member **1** into the enclosure member whilst it is still magnetically supported from the contact member **2**. The coils **7** and **8***b* are then deenergised in order to remove the magnetic attractive force between the contact members **1** and **2**; this magnetic attractive force is now no longer necessary since the contact member **1** which is now sealed into the enclosure member, is now supported by the enclosure member support (not illustrated).

Relative movement between the enclosure member support and the collet **6** is now initiated by means not illustrated to produce the desired separation between the flattened ends **1***a* and **2***a*. This may be effected at the same station at which the seal **4** was formed or at a subsequent station of the apparatus.

The contact member **2** is then sealed by means not illustrated in FIG. **2**, as indicated at **5** in FIGS. **1***a* and **1***b* to the enclosure member, thereby causing the contact members **1** and **2** to be held within the enclosure member **3** with the desired separation between the overlapping ends.

The pin **8***a* may, alternatively be provided by a permanent magnet to effect the alignment in which case, the coil **8***b* would not be required and the member **8***c* would need to be of a non-magnetic material. In order to prevent the permanent magnet from affecting the alignment of the contact members when the unit **8** is moved to allow loading of the enclosure member, it may be necessary to have a movable magnetic shunt or a movable soft iron flux-directing member, to redirect the axial lines of magnetic flux away from the contact members i.e., out of alignment with their longitudinal axes.

The seals **4** and **5** can be made utilising various heating arrangements, and in particular can be made utilising the arrangement diagrammatically illustrated in a plan view in FIG. **3** of the drawings. The arrangement illustrated in FIG. **3** would be situated one at each end of the enclosure member **3**, at the same or preferably different stations of the apparatus according to the invention in positions where it is desired to form the seal.

The sealing arrangement basically consists of an infra-red radiation source **10**, and a reflector **11** which directs the output of the source **10** towards the enclosure member **3** at a position where it is desired to form the seal. The surface **12***a* of a reflector **12** causes the radiated heat, after passing through the walls of the enclosure member to be reflected back to that side of the enclosure member **3** which is remote from the source **10**. The enclosure member **3** must, therefore, for this arrangement, consist of an infra-red absorbing glass. The heat source, usually a tungsten halogen lamp, may be mounted external to a sealed housing within which the remainder of the apparatus is enclosed when it is required to produce a gas filled contact unit, the infra-red energy being passed through a suitably transmitting window in the housing, or located within the sealed housing. In order to provide a symmetrical seal shape, the infra-red absorbing properties of the glass which is utilised for the enclosure member **3** is arranged such that the radiant heat from the source **10** on passing through the enclosure member **3** absorbs approximately 50 percent of this radiant heat, the remaining radiated heat being reflected back from the surface **12***a* of the reflector **12** towards the enclosure member **3** thereby inducing sufficient heat into the enclosure member to effect the sealing operation.

It is of course possible to provide at each station of the apparatus at which a sealing operation is performed, two or more of the infra-red heat sources **10** in order to simultaneously seal a plurality of reed contact units.

During the sealing operation outlined in preceding paragraphs the radiated heat which effects the sealing may also be utilised to modify the characteristics of the contact coating, for example, to anneal, diffuse, or outgas the contact coating, in order to improve the switching characteristics of the contact unit.

The radiated heat from the source **10** is not only absorbed by the enclosure member **3**, it is also absorbed by the contact members and thereby causes them to be heated to a temperature which can be controlled, within the temperature limits which are necessary to obtain the correct type of seal, by varying the intensity of the heat radiated by the source **10** and/or its period of application. Thus, in practice, when it is desired to modify the characteristics of the contact members, the temperature of the contact members is raised, during the sealing operation or subsequently by means of additional infra-red heat sources to a value which is sufficient to cause the physical characteristics of the contact coating thereon to be modified.

The contact material that is utilised for coating the flattened end portion of each of the contact members can include a metal-organic complex which, when the temperature of the contact material is raised during the sealing operation or subsequently by means of additional infra-red heat sources to a value which effects a change in the physical characteristics of the contact material, causes gases and vapours to be produced which mix with the filling gas and result in an improvement in the switching characteristics of the cont,ct unit.

As previously stated, those parts of the apparatus which facilitate the assembly of the contact units can be enclosed within a sealed housing during the sealing operations in order to allow the enclosure member **3** to be filled with a gas before the final seal is made, the gas composition being contained within the sealed housing. Under these conditions, the order of assembly of the parts of the contact units may be changed and can result in an improvement in the quality and operating characteristics of the contact units.

This change in assembly order involves the collet **6** and the unit **8** changing positions i.e., the collet **6** would be situated in an upper position of the apparatus and the unit **8** in a lower position. Thus, the first contact member i.e., the contact member **1** of FIG. **1**, to be loaded into the apparatus would be such that its flattened end would be lowermost and therefore when the other contact member, i.e., the contact member **2**, is magnetically held to the contact member **1** its alignment therewith would be assisted by gravity as well as by the unit **8**.

This method of assembly also gives a distinct improvement in the shape and strength of the seals **4** and **5** (see FIG. **1**).

Since the magnetically held contact member is now the lower one, and it is this one that is always sealed into the enclosure member first, it will be the lower seal **5** which is the first one to be made and not the upper one, therefore, the shape of the glass/metal seal is affected only by gravitational effects, i.e., the molten glass tends to flow away from the centre of the contact unit. With the normal method of assembly it is the upper seal that is made first and the affects of gravity are such that the molten glass tends to flow towards the centre of the contact unit. The shape and strength of the seal with the normal method of assembly is therefore difficult to predict and control.

When the upper seal, i.e., the second seal, is made in the modified production method, the downward flow of molten glass, due to gravitational effects, is counteracted by the gas pressure within the now enclosed volume of the member **3.** This pressure will be higher than the pressure within the sealed housing and therefore results in a better shaped and stronger seal than is obtained for this seal in the normal production method since it counteracts to a greater degree the downward flow of molten glass.

It is to be understood that the foregoing description of specific examples of this invention is made by way of example only and is not to be considered as a limitation in its scope.

What is claimed is:

1. A method of producing magnetic reed contact units, each having two flexible contact members of a magnetically permeable material, each of said members having one end which is flat, said method being particularly useful where components of said units may be subject to acceleration during the production of said units, comprising the steps of supporting the other end of the first of said contact members vertically in a support means, positioning the second of said contact members so that its axis is in substantial alignment with that of said first contact members and so that said flat faces of said contact members overlap each other at least in part vertically and are in registry from side-to-side, applying a first magnetic field by first magnetic means to the other end of said first contact member, applying a second magnetic field by a second magnetic means to the other end of said second contact member, said second field being of polarity such as to augment said first field and of such strength as to ensure against any relative displacement of said contact members even when said contact members are subjected to acceleration, removing said second magnetic means while said contact members are stationary to permit emplacement of an enclosure member over said contact members, passing a double open-ended enclosure member of a fusible material over said contact members, replacing said second magnetic means to augment said first magnetic field, sealing said magnetically supported and magnetically aligned second contact member to said enclosure member, removing both magnetic means, said second contactmember now being supported by said enclosure member, causing relative movement between said first and second contact members to bring about a desired separation between the overlapping contact faces thereof, the direction of said relative movement being essentially perpendicular to the planes of said flat faces, and sealing said first contact member to said enclosure member while said contact members are spaced apart, the space between and the flexibility of said contact members being such that the flat faces thereof can readily be brought into contact by application of a magnetic field of suitable strength.

2. A method as claimed in claim **1** wherein a filling gas is introduced into the enclosure member prior to the sealing of the first contact member to the enclosure member.

3. A method as claimed in claim 2 wherein the first contact member is supported such that the said other end thereof is lowermost in relation to the said one end thereof, the alignment of the second contact member and the formation of the seals being assisted by gravitational effects.

4. A method as claimed in claim 1 wherein the enclosure member is of an infra-red absorbing glass, and wherein the seals are formed by infra-red radiation.

5. A method as claimed in claim 1 wherein a contact coating on the overlapping ends of the contact members is subjected to infra-red radiation, the intensity and/or the period of application of which is or are selected such that the physical characteristics of the contact coating are modified to give improved switching characteristics for the contact unit.

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