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K. B. PRIVAL
RESILIENT TWIN NONMAGNETIC AUXILIARY CONTACTS FOR
MINIATURE DRY REED SEALED SWITCH

3,254,173

Filed June 29, 1964

2 Sheets-Sheet 1

FIG. 1

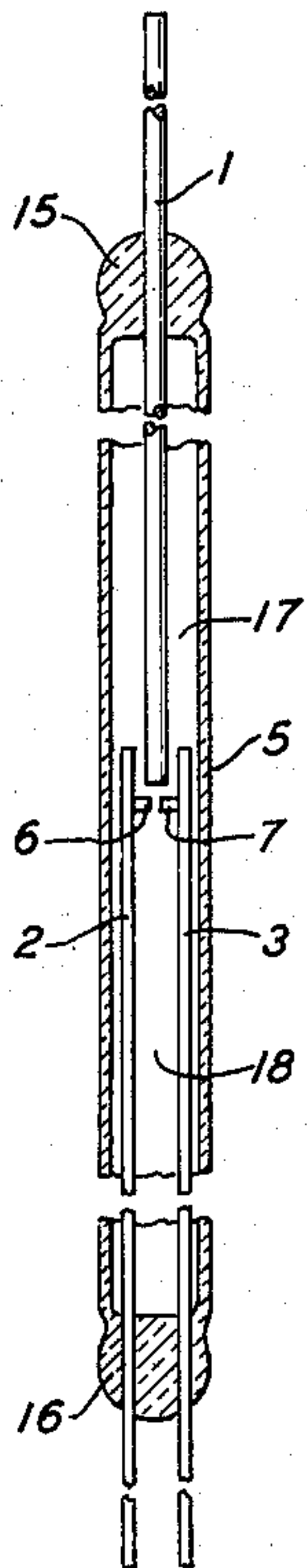


FIG. 2

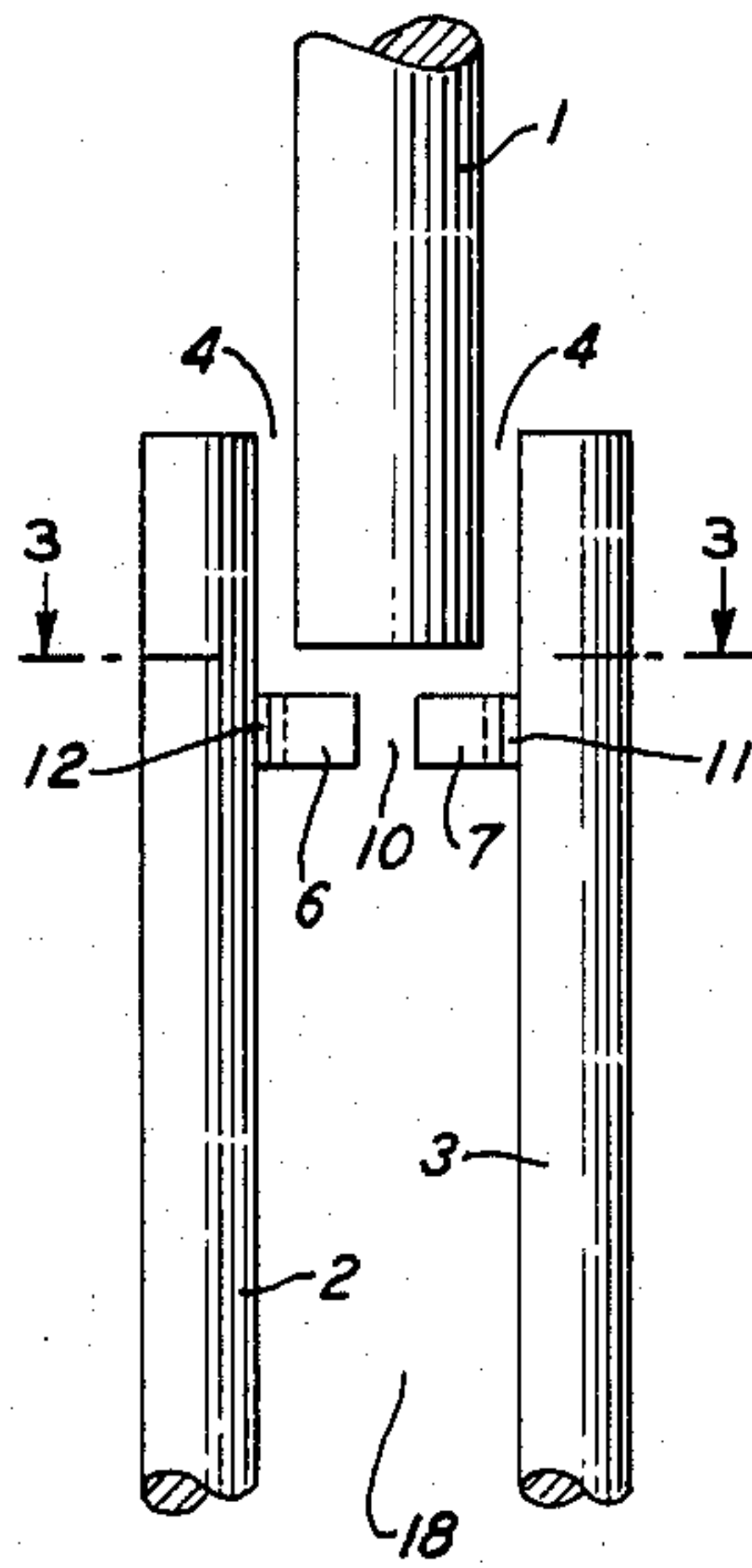


FIG. 2A

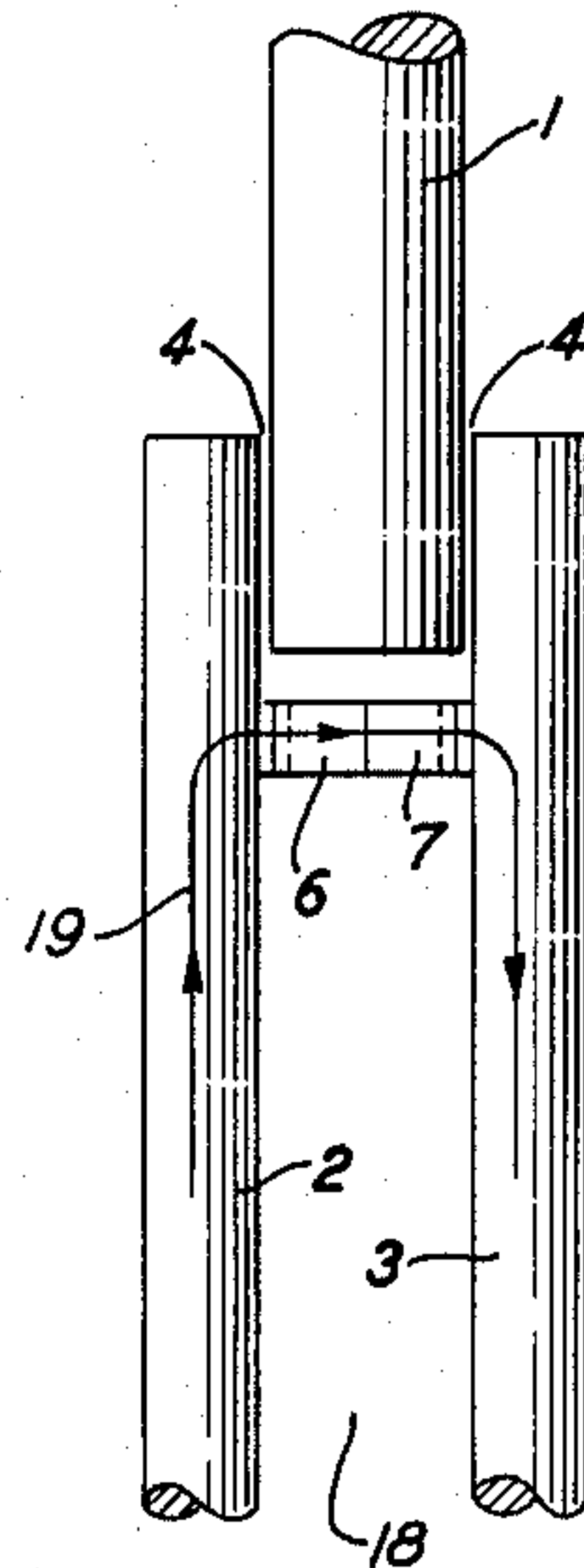


FIG. 3

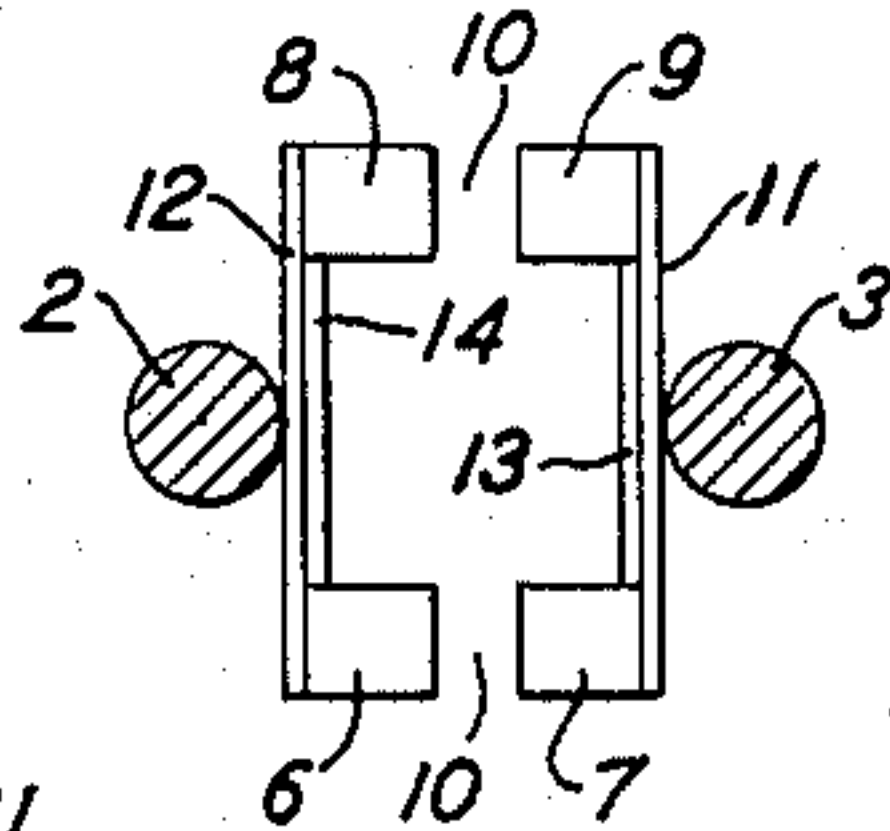


FIG. 3A

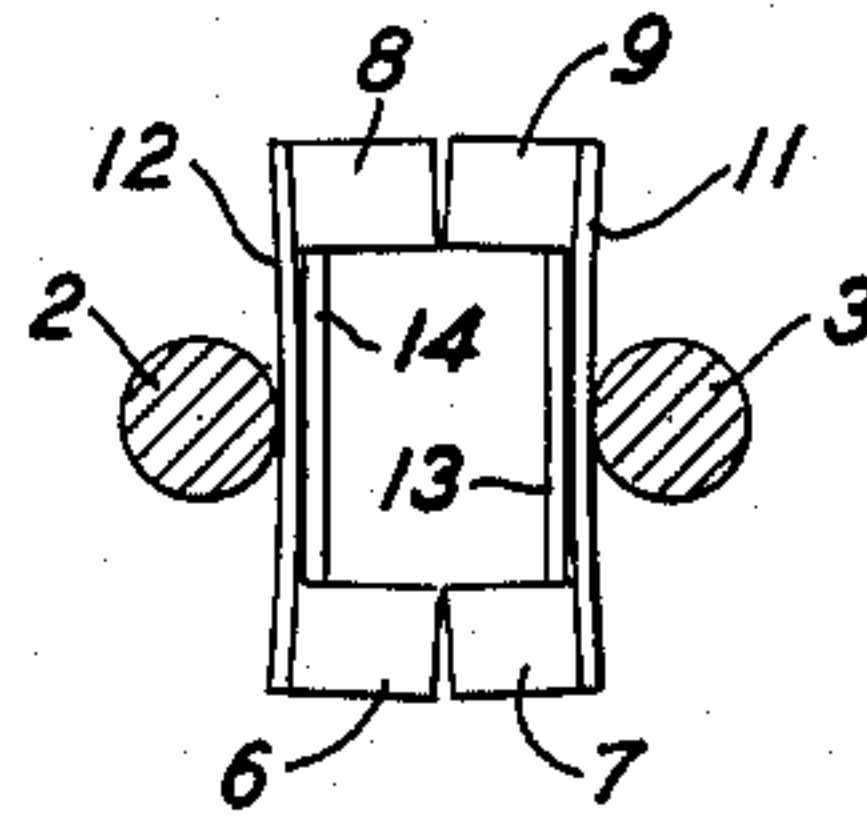


FIG. 6A

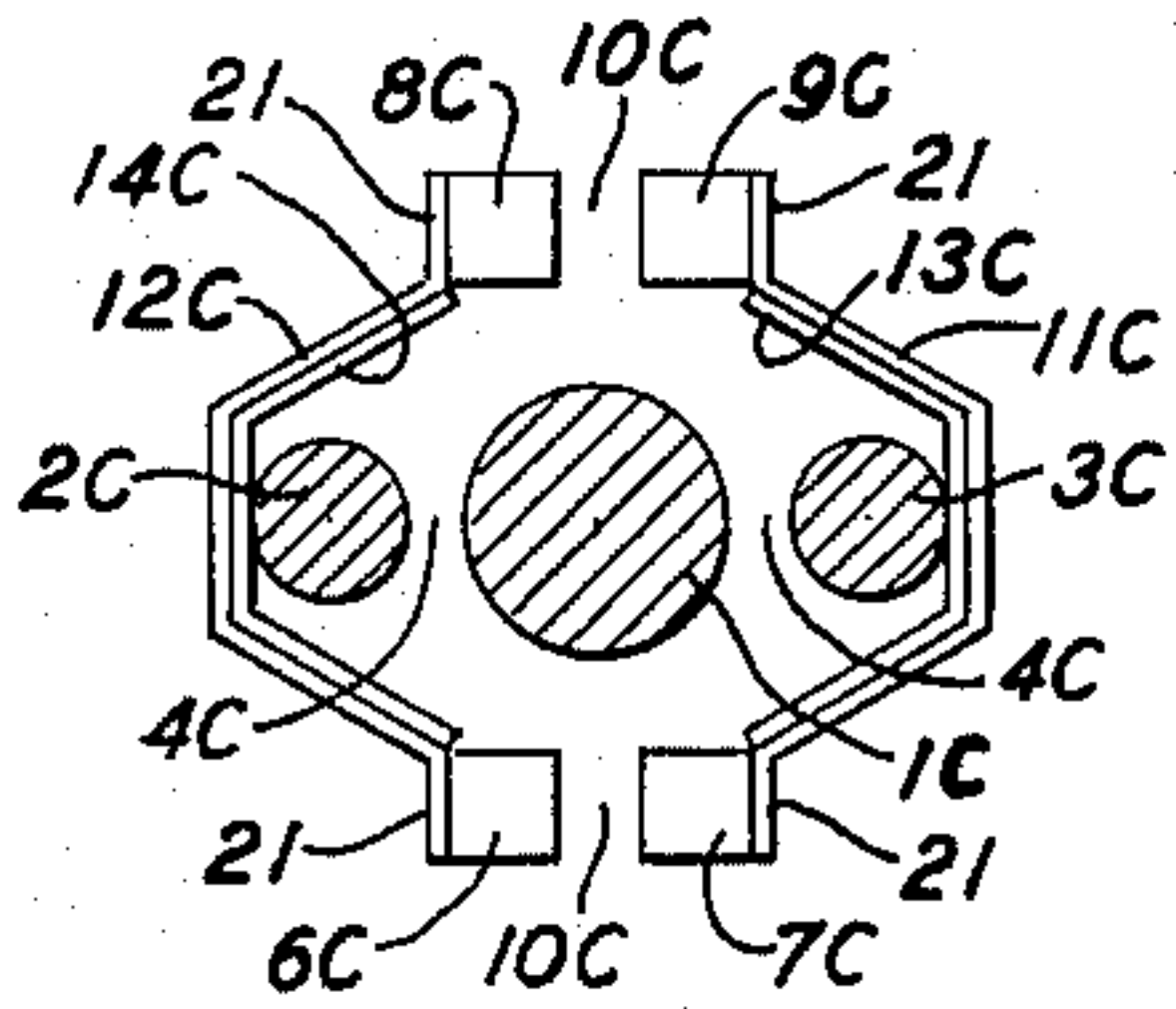


FIG. 4

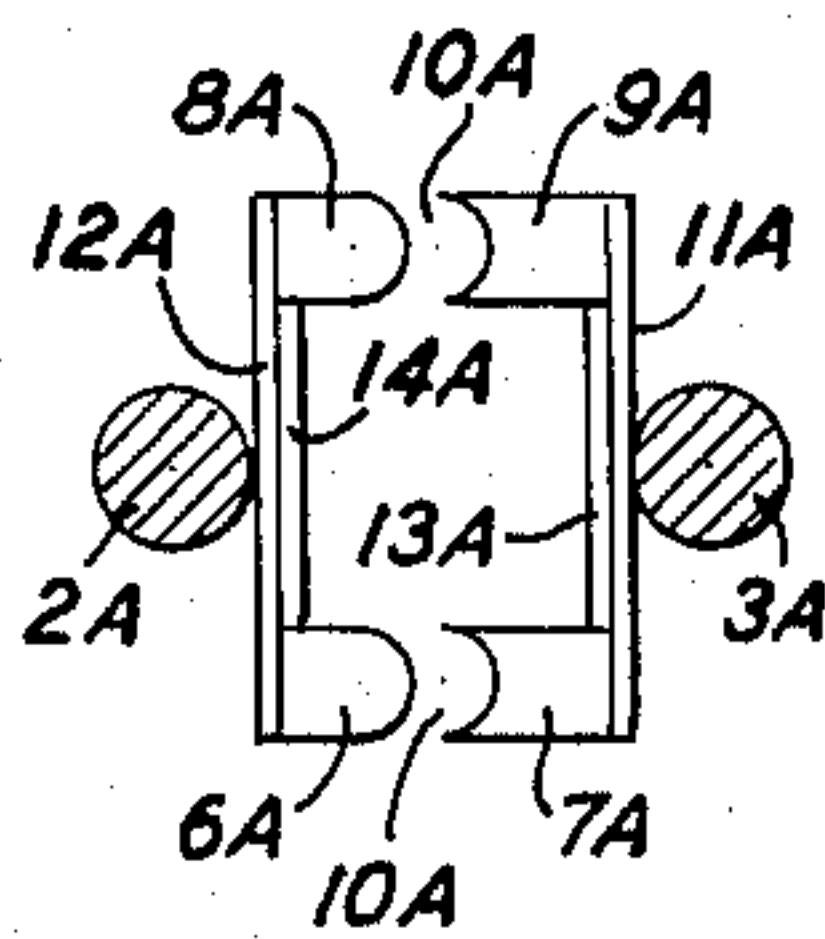


FIG. 5

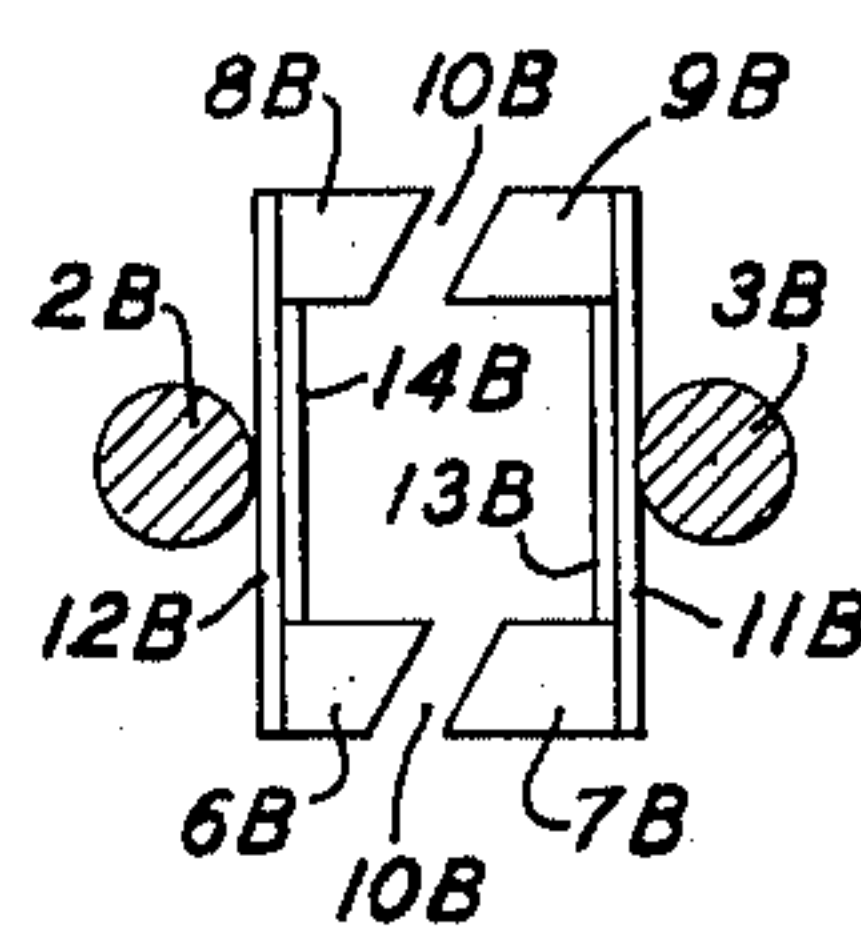
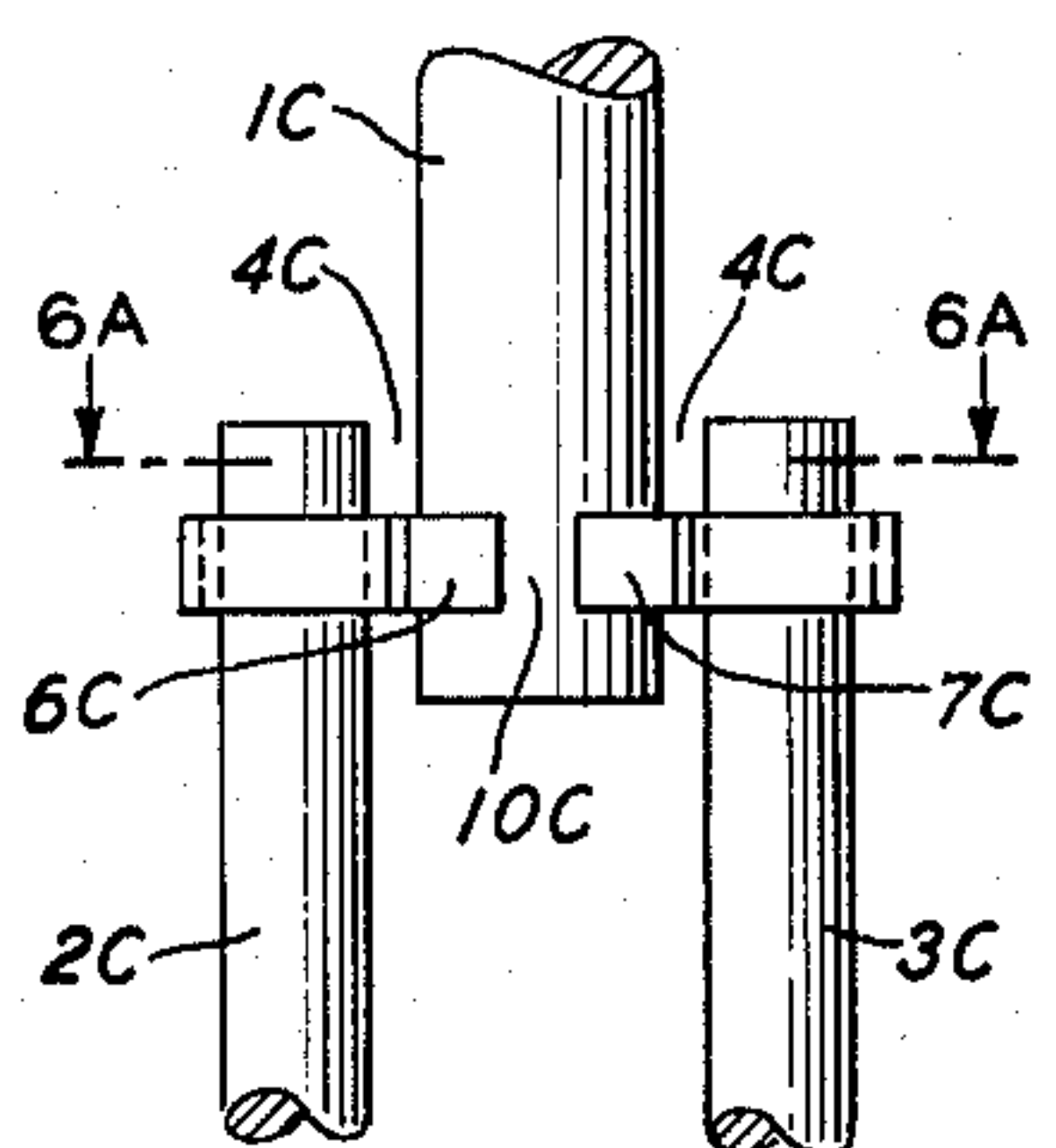


FIG. 6



INVENTOR
K. B. PRIVAL
BY *E. Olinder*
ATTORNEY

May 31, 1966

K. B. PRIVAL

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FIG. 7

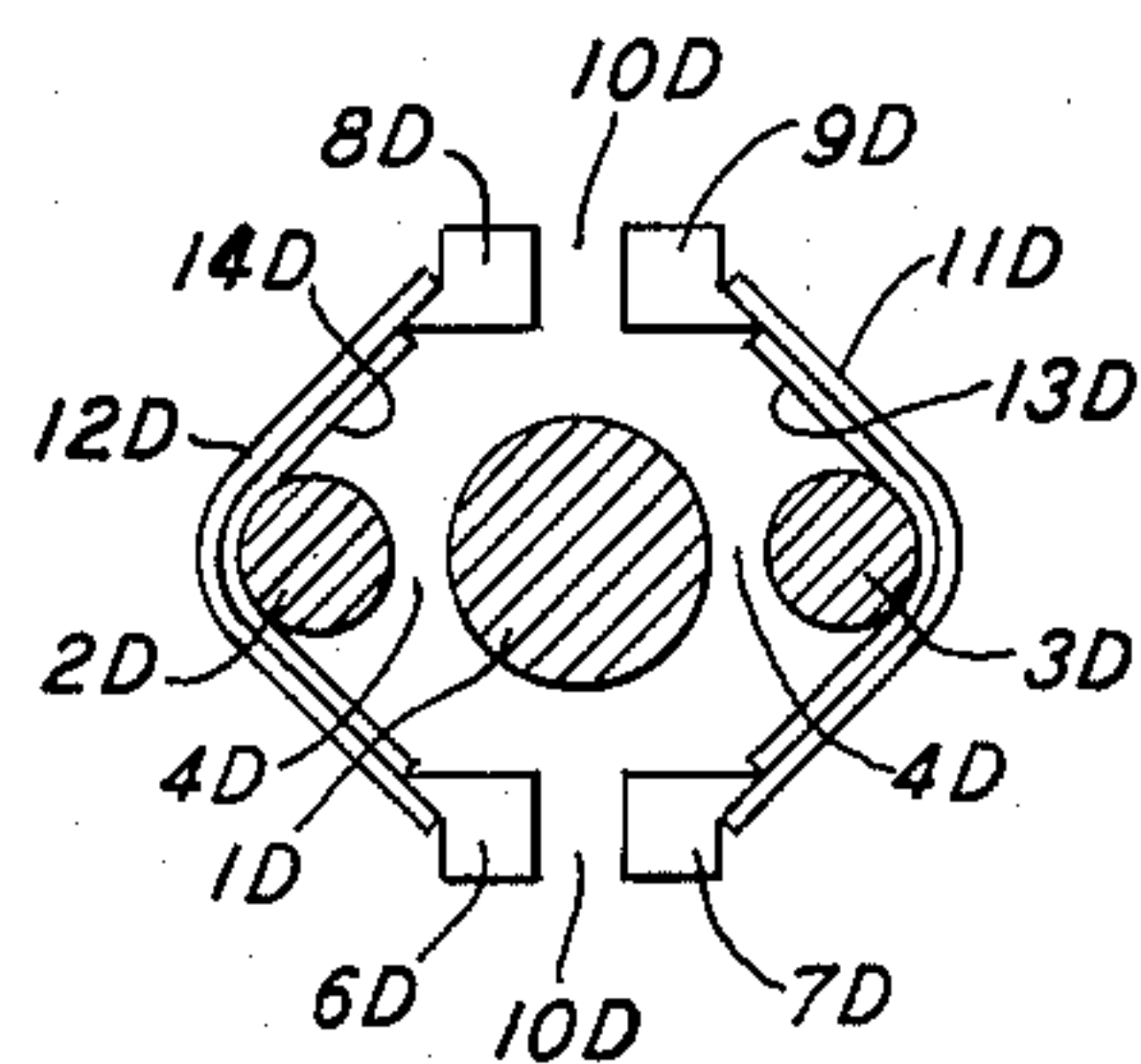


FIG. 8

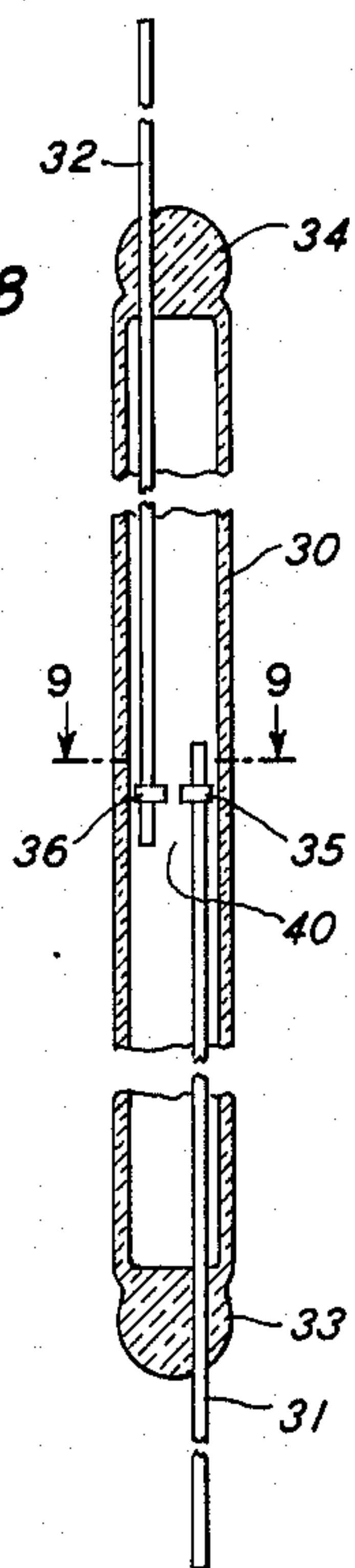
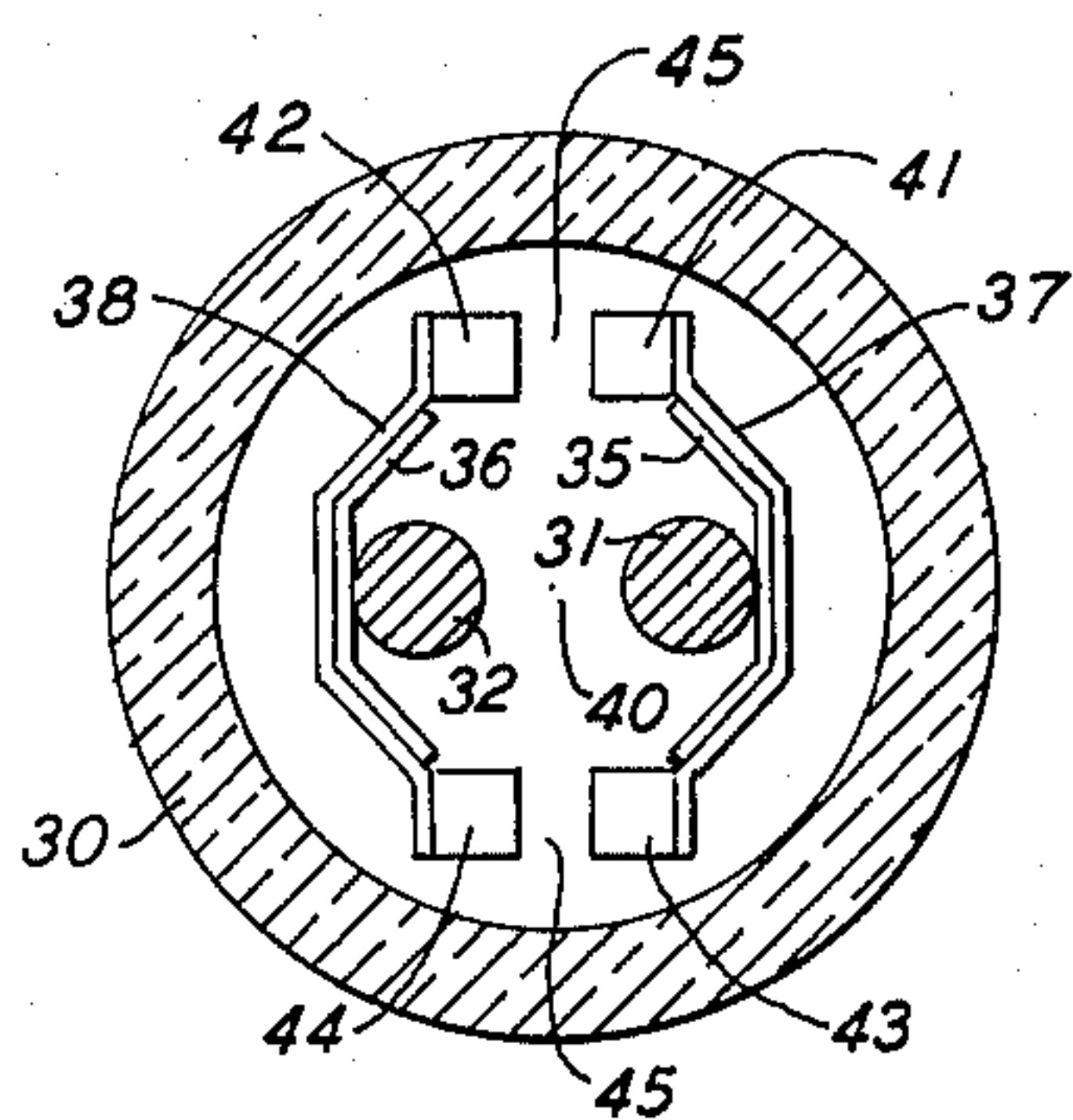


FIG. 9



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RESILIENT TWIN NONMAGNETIC AUXILIARY CONTACTS FOR MINIATURE DRY REED SEALED SWITCH

Katharine B. Prival, Croton-on-Hudson, N.Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

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12 Claims. (Cl. 200-87)

This invention relates to miniature dry reed sealed switches and more particularly to a twin contact arrangement of resiliently mounted nonmagnetic contacts. The general object of the invention is to lengthen substantially the useful life of a miniature dry reed sealed switch.

Dry reed sealed switches typically include two and sometimes three magnetic reed members suspended through the ends of an elongated gas-filled glass envelope in spaced generally parallel relation with overlapping end portions. The end portions of these reeds comprise the contacting surfaces through which current passes, and normally have been plated with a nonmagnetic contact material to improve the wear characteristics under different operating conditions. In general, such plating can reduce arcing, lessen buildup of magnetic debris, lower the contact resistance and lessen the likelihood of contact sticking.

The degree to which these effects will be achieved and maintained in a given switch is a function of, among other things, the thickness of nonmagnetic plating or material. This thickness in turn is limited by several considerations relating to the magnetic gap dimension. For example, in applications where the breakdown voltage is a factor, at least a six-mil normal magnetic gap between contacts is desirable. Also, for a given reed material the maximum allowable gap is limited in large measure by the dimensions of the reeds which determine the flux-carrying capacity. On the other hand, the retractile force necessary to open the reeds and maintain them in their normally spaced relationship is obtained by a separation of the reeds. Additionally, metal plating increases the magnetic force necessary to operate the switch. Applying these considerations to a miniature dry reed sealed switch, if plating is used its thickness must be limited as a practical matter to less than .2 mil. Since this is a relatively minute thickness of erodable plating, the durability of the switch is limited.

A switch which employs auxiliary nonmagnetic metal contact pieces that are structurally separate from the magnetic members can improve the wear characteristics. For example, a sealed dry reed switch having first and second overlapping reeds supported in opposite ends of a glass envelope may be converted to an auxiliary type switch by incorporating in the first reed a nonmagnetic contact piece spaced a few mils away from the overlapping contact portions, and then fixing one end of a flexible member to the second reed with its other end, that includes a second nonmagnetic contact piece, in spaced parallel relation to that of the first reed. The magnetic portions of the switch and the contact pieces are so spaced that, on application of flux, the contact pieces touch first with a relatively reduced contact force before the reeds meet. The contact force increases until final closure of the reeds. This feature reduces somewhat the tendency of the members to chatter; and since the auxiliary con-

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tacts are nonmagnetic the problem of debris accumulations in the gap area is lessened. Arrangements such as described are well known in the prior art as shown, for example, in Patent 2,892,052 issued on June 23, 1959, to A. C. Ducati.

The contact configuration described above has certain inherent limitations when applied to the miniature sealed reed switch art. For example, the thickness of the nonmagnetic metal contacts which can erode through normal wear before the switch no longer operates is limited to a dimension that is substantially less than the magnetic gap distance between the reeds. In the case of a miniature dry reed switch the magnetic gap must be relatively small. Consequently, in the switch described above, if the magnetic gap is six mils, and the contacting pieces themselves must be separated by about four mils when the switch is in the open mode, it is apparent that only about one mil of each of the contact pieces can erode before the switch becomes inoperative. For applications such as electronic switching systems requiring many miniature sealed reed switches having extremely long life and high reliability, the above-described contact configuration would constitute a relatively weak point.

A related problem to which known miniature dry reed sealed switch art offers no suitable solution involves the breaking apart of the contacts in positive fashion to prevent their sticking. In a switch relying on magnetic flux to provide contact force, the related retractile force works to break the contacts apart as well as restore the reeds to a normal spaced position. This retractile force is a function of the reed material and configuration, and also the gap between reeds. In a switch employing two spaced overlapping reeds with contacting end portions, the only force present with which to break the end portions apart resides in the spring tension of the reeds themselves resulting from the gap. In the auxiliary contact device described above where, upon opening, the magnetic reeds separate before the auxiliary contacts, part of the kinetic energy of the reeds is applied in gradual fashion to the contacts to urge them apart. If, in addition, part of the reed kinetic energy were converted through suitable means to an impact force applied to the contacts, such force inherently would be more effective in breaking the contacts apart.

Accordingly, an object of the invention is to eliminate substantially the occurrence of sticking of the contacting members in such a switch.

Another object of the invention is to minimize erosion across the contacts when an arcing circuit condition occurs.

Another object of the invention is to minimize the tendency of a miniature dry reed sealed switch to chatter.

A further object of the invention is to maintain the contact resistance within such a switch at a very low level throughout its life.

A further object of the invention is to increase the reliability of a miniature dry reed sealed switch.

These and other objects are accomplished in accordance with the principles of the invention by the employment in a miniature dry reed sealed switch of a plurality of nonmagnetic metal contact pieces that are resiliently supported to allow backward deflection on closure, to prevent forward deflection beyond a preselected amount on opening and to break apart abruptly and very rapidly.

In the first switch hereinafter described to illustrate

the inventive concept, a first and a second magnetic reed member are mounted in spaced parallel relation through one end of a sealed glass envelope, and a third reed through which the flux is applied is mounted through the other end of the envelope and overlaps into the gap between the parallel reeds. A backward-deflectible spring support member is fastened at right angles onto each of the first and second reeds so that the support members are themselves in parallel face-to-face relation when so mounted. At both ends of each of these support members are then mounted the nonmagnetic auxiliary contact members in such fashion that the contacts oppose one another in paired face-to-face relation across a contact gap. A rigid reinforcement member is attached to each of the support members to prevent forward deflection of the support member, as will be described in greater detail later. The foregoing defines the open position of this switch.

In accordance with the invention, the switch operates in the following manner. When magnetic flux is applied through the middle reed member, the movable magnetic reeds close toward one another and the nonmagnetic contact members are the first to contact. When this contact occurs the spring supports deflect and absorb the energy of impact, substantially eliminating any tendency to chatter. Rebounding of the movable reeds could occur fully to the extent that the spring supports have deflected, yet the nonmagnetic members will stay in contact. The magnetic reeds continue to close until they contact. This position defines the operated mode of this switch. When the flux is removed, the magnetic reeds are first to separate. Current will continue to flow through the nonmagnetic members and consequently no arcing between the magnetic reeds will occur. The wear at the magnetic contact surfaces is therefore only mechanical.

As the switch continues to open, the support members on which the contacts are mounted regain their normal straight shape. Although the contacts are nonmagnetic and would not be inclined to stick together because of residual magnetism, it is still possible that enough contact voltage would be present to cause repeated breakdown and current surges that result in sticking. In this event, in accordance with the invention, the reed reinforcement members mounted on each of the supports come into play and prevent said supports from further deflecting in a forward direction. Additionally, the reinforcement members deliver to the support members an impact force, causing the contacts to break apart cleanly and at a very high rate. In accordance with the invention, therefore, the twin contacts are separated at a time when the reeds to which they are fastened are moving apart at a very high rate due first to their own spring action and secondly to the accelerating action of the two spring supports as they regain their normal shape. Specifically, this high separation rate reduces the number of repeated voltage breakdowns across the contact pairs during opening; and thereby reduces the number of surges, which results in reduced erosion. The circuit noise thus generated becomes negligible for most applications.

The three-reed auxiliary twin contact arrangement has further important advantages over a two-reed auxiliary contact device with or without twin contacts. In accordance with another feature of the invention for the same contact gap width and the same allowance for erosion in each case, twice as much magnetic gap is achieved in the three-reed configuration. As a result, considerably more retractile force and higher separation rate are present in the three-reed switch to overcome any tendency of the contacts to stick. If more erodable volume of contact metal is desired, this also may be achieved by sacrificing some of the magnetic gap advantage. The resulting switch has both greater magnetic gap width and greater volume of erodable metal than the two-reed switch. In addition, of course, employment of twin auxiliary contacts of itself doubles the erodable metal volume apart from any ad-

vantages stemming from the greater realizable magnetic gap.

In accordance with a further feature of the invention, the employment of twin auxiliary contacts permits the intermittent dissipation of the load energy across one or the other of the auxiliary contacts, which prolongs contact life by a considerable factor. Additionally, the parallel arrangement of all contacting members and the backward deflection of the contact pairs upon contact causes a slight wiping action at the contacting surfaces which promotes a low contact resistance throughout the life of the switch.

Yet a further feature of the invention relates to the enhanced usage of certain metals for the auxiliary contacts. Certain nonmagnetic contact metals which have highly desirable resistivity and wear features but which have a tendency to cold-weld during prolonged closure may be employed as contacts with greater safety in the invention described. The high contact separation rate and the impact force imparted to the contact supports by the reinforcement member force the undoing of any cold-weld that may have occurred between contacts.

Accordingly, a feature of the invention is twin nonmagnetic contacts that are structurally separate from the magnetic members, which provide a wider effective gap between contact pieces and which increase the available volume of erodable metal that can be used so as to prolong switch life.

Another feature of the invention is the intermittent load energy dissipation possible through the twin nonmagnetic contacts.

A further feature of the invention is the support members for the contact pieces which allow backward deflection and which tend to equalize the contacting force occurring at each of the contacting surfaces.

A still further feature of the invention is the reinforcement members which prevent any forward deflection of the support members upon opening of the switch.

These and other objects and features of the invention will be readily apprehended from the following detailed description of an illustrative embodiment of the invention and from the appended drawing in which:

FIG. 1 is an elevation view in partial section of the entire switch;

FIG. 2 is an enlarged view of the contact area within the switch;

FIG. 2A shows the reed positions at initial contact of auxiliary members;

FIG. 3 is a sectional view showing one configuration of the twin contact arrangement in open position;

FIG. 3A shows the contacts at full closure with support members fully deflected rearwardly;

FIG. 4 shows an alternative shape for the mating surfaces of the auxiliary contacts;

FIG. 5 shows a second alternative shape to mating surfaces of the twin contacts;

FIG. 6 shows in elevation an alternative shape and fastening position for the spring supports and reinforcement members;

FIG. 6A is a sectional view taken of FIG. 6;

FIG. 7 shows in sectional plan a third alternative shape for the spring supports and the reinforcement members;

FIG. 8 is an elevation view of a two-reed switch; and

FIG. 9 shows the twin contact arrangement employed on a two-reed switch.

Referring first to FIGS. 1 and 2, the miniature dry reed sealed switch consists of a rigid magnetic reed 1 mounted through one end 15 of evacuated or gas-filled glass envelope 5, and a first flexible reed 2 and a second flexible reed 3 mounted in spaced parallel relation through the other end 16 of glass envelope 5. Although reeds 1, 2 and 3 are shown as circular in cross section any or all of them could be square or rectangular, depending upon the operating characteristics desired. The end por-

tion of reed 1 extends slightly into the gap 18 between flexible reeds 2 and 3 in such fashion that the resulting magnetic gaps 4 at either side of rigid reed 1 are equal. Beyond the overlapping portions of flexible reeds 2 and 3 are mounted respectively spring supports 11 and 12 at right angles to the reeds and in spaced parallel relation to one other. Auxiliary nonmagnetic contacts 6 and 7 shown in FIG. 2 are fixedly mounted respectively on supports 12 and 11. The mountings mentioned thus far may advantageously be accomplished through a process such as welding. Reeds 1, 2 and 3 are fabricated of a high permeability material such as 52 alloy; and supports 11 and 12 of a suitable spring material.

Referring now to FIG. 3 the twin auxiliary contact arrangement is shown with contacts 6 and 8 rigidly mounted upon spring support 12 and opposed by contacts 7 and 9, respectively, which are rigidly mounted on support 11. Contacts 6 and 7, and contacts 8 and 9 oppose each other in the normally open position across a gap 10. Reinforcement members 13 and 14 are fastened to spring supports 11 and 12, respectively, at the midpoints only. Members 13 and 14 are parallel to one another and also to the support members on which they are mounted.

FIGS. 2 and 3 show the miniature switch in its normal or unoperated position. In the embodiment of the inventive conception as shown, magnetic flux is applied through magnetic reed 1. When this occurs movable reeds 2 and 3 are attracted at about the same rate of closure toward rigid magnetic reed 1, across magnetic gaps 4. As the switch closes, opposing auxiliary contacts 6 and 7, and opposing auxiliary contacts 8 and 9 approach across gaps 10. As shown in FIG. 2A the auxiliary contacts are the first to close and current flows in the direction of arrow 19 before reeds 2 and 3 have completed their travel toward rigid reed 1 across gaps 4. At this point first and second reeds 2 and 3 are still a slight distance from rigid reed 1, and spring supports 11 and 12 are still in their normal straight position shown for example in FIG. 3. During further closure of reeds 1 and 2 upon reed 3, contacts 6 and 8 abut with increasing force upon contacts 7 and 9, respectively. Spring supports 11 and 12 deflect backward until at full closure, as shown in FIG. 3A in exaggerated fashion, springs 11 and 12 are each fully deflected at their respective end portions. The contacts have closed with a gradually increasing contact force due to the follow-through of the supports 11 and 12, to minimize the tendency to rebound. It is seen that any rebounding which might occur will be opposed by the spring action of supports 11 and 12 which keeps the auxiliary members pressed against one another.

The auxiliary contacts 6, 7, 8 and 9 shown in FIG. 3 to illustrate the invention have been shown as essentially square or rectangular in cross section and have flat contacting surfaces. The contacting surfaces will have a tendency both to wipe and to rock across one another because of the backward deflection of spring supports 11 and 12 on final closure. The rocking and wiping action is advantageous because it keeps the contact surfaces free of any debris and eventually allows the contacts to assume an optimum contact interface. A very low contact resistance level thereby is promoted and maintained.

At full closure as seen in FIG. 3A, the reinforcement members 13 and 14 are separated at their end portions respectively from spring supports 11 and 12 by a slight gap created by the backward deflection of the latter two members. When magnetic flux is removed, magnetic reeds 2 and 3 readily break away from magnetic reed 1. As long as the auxiliary contacts remain closed, current will continue to flow as shown in FIG. 2A by arrow 19. When the gaps 4 between the magnetic reed 1 and the first and second reeds 2 and 3 have widened a predetermined amount, for example, one mil, spring

supports 11 and 12 have returned to their straight undeflected shapes and current is still flowing through the auxiliary contacts. In the next instant as reeds 2 and 3 continue to travel apart, spring supports 11 and 12 abut respectively against the rigid reinforcement members 13 and 14 illustrated in FIG. 3, which prevents any forward deflection of members 11 and 12. Any tendency for contacts 6 and 7 to stick or any tendency of contacts 8 and 9 to stick is effectively thwarted by not allowing spring supports 11 and 12 to deflect forward. Furthermore, the travel of members 13 and 14 against members 11 and 12, respectively, has the effect of imparting an impact blow to the latter members, further urging the auxiliary contacts apart in a clean break to lessen the number of breakdowns, and to unstick the contacts should they have cold-welded together.

An alternative shape for the precious metal auxiliary contacts is seen in FIG. 4 which is a sectional plan view similar to FIG. 3, and in which corresponding parts are similarly numbered. Contacts 6A and 8A are convex at their end portions while the corresponding contacts 7A and 9A are formed with a concavity of about the same radius. This arrangement has the advantage that the opposing contacts pairs are contacting over a greater mating interface from the instant of initial contact until full closure when the support members have deflected backward. This contact configuration enables the opposing auxiliary contact pieces to contact in a combination rolling and wiping action. Reinforcement members 13A and 14A perform the same function as their counterparts shown in the FIG. 3 configuration.

FIG. 5 depicts a further alternative design for the auxiliary contact pieces wherein the mating interface across gap 10B is at a slight angle with respect to the support members 11B and 12B.

FIG. 6 illustrates a modification of the twin contact arrangement utilizing nonmagnetic contacts. The contacts and their supporting springs are mounted on the outside of flexible reeds 2 and 3 rather than the inside as, for example, in FIG. 3. As shown in FIG. 6, fixed magnetic reed 1C overlaps into the gap between the ends of flexible reeds 2C and 3C. Reinforcement members 13C and 14C may be fixedly mounted in this case to the outside surface of flexible reeds 2C and 3C, respectively, in a number of possible positions relative to the magnetic members. One such position shown in FIG. 6 is for the members to be mounted in the overlapping region.

Referring to FIG. 6A reinforcement members 13C and 14C are rigidly mounted at their midpoints on reeds 3C and 2C, respectively, on the reed surfaces which are opposite to the magnetic gaps 4C. Members 13C and 14C are each angular in shape so that their end portions bend in toward the fixed reed 1C. Spring supports 11C and 12C are mounted at the midpoints of the respective reinforcement members and in their unoperated position shown in FIG. 6A have the same general angular shape as members 13C and 14C. Each spring support has two angular end portions 21 to which the opposing sets of nonmagnetic contacts are fixed. Contact gaps 10C are slightly greater than the magnetic gaps 4C, as was also the case in the previous embodiments. On closure, supports 11C and 12C deflect rearwardly and also outwardly away from the reed 1C in a spreading motion. Opposing contact pairs 6C, 7C, 8C, 9C have less of a tendency to rock in this configuration.

A further variation in the spring support and reinforcement members is shown in FIG. 7. The construction and operation is similar to that described in connection with FIG. 6A except that reinforcement members 13D and 14D and spring supports 11D and 12D are generally U-shaped.

The inventive concept may be practiced also in other types of dry reed sealed switches such as, for example, a two-reed device. FIG. 8 shows one possible configuration comprising a first reed 31 and a second reed 32 seal-

ably suspended in spaced overlapping relation within a glass envelope 30 at the end portions 33 and 34. At about the midpoint of the overlapping area reinforcement member 35 is mounted on reed 31 on the side opposite the magnetic gap 40 between the reeds. Reinforcement member 36 is mounted on reed 32 on the side opposite gap 40 and in juxtaposition to member 35. Members 35 and 36 have the same shape and function as do members 13C and 14C shown in FIG. 6A.

FIG. 9 shows the twin contacts and their support means. Spring supports 37 and 38 are fastened at the midpoints of members 35 and 36, respectively, and have the same general angular appearance as the reinforcement members. The ends of supports 37 and 38 are parallel and secure the opposing pairs of nonmagnetic contacts 41, 42 and 43, 44. Contact gaps 45 are slightly less than magnetic gaps 40 so that on closure the opposing pair of contacts are first to touch. When this occurs, supports 37 and 38 deflect rearward until gaps 40 are closed. On opening, reeds 31 and 32 separate, and spring supports 37 and 38 deflect in a forward direction until they abut respectively reinforcement members 35 and 36 which prevent their further forward deflection and deliver an impact blow to the spring supports causing in turn the opposing contact pairs to break cleanly apart.

In any of the embodiment described, the nonmagnetic auxiliary contacts may be fabricated from a wide range of metals in accordance with the characteristics required in a given application. The noble metals—gold, platinum and silver—are noted for their lower resistivity, while tungsten and molybdenum may be suitable where hardness and high melting points are required. Metals such as gold and silver which have a tendency to cold-weld with prolonged closure in some applications may be employed with greater safety and to considerable advantage in the invention described because of its novel break features.

While several preferred embodiments of the inventive concept have been shown and described, it is to be expressly understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A sealed reed switch comprising first and second magnetic reeds in spaced and at least partial overlapping relation and having an open and an operated position, means including a varying magnetic flux for moving said first and second reeds to and from said open and operated positions, contacting means responsive to application of said flux for making electrical contact between said first and second reeds at a preselected distance from their operated position, said contacting means being further responsive to removal of said flux for maintaining electrical contact between said first and second reeds after said reeds leave their operated position and until said reeds return to said preselected distance from said operated position, and means responsive to return of said reeds to said preselected distance for abruptly urging said contacting means apart.

2. Apparatus in accordance with claim 1 wherein said contacting means comprises substantially parallel first and second support means connected respectively to said first and second reeds, a first pair of metallic contact members fixedly mounted at opposite ends of said first support means, and a second pair of metallic contact members fixedly mounted at opposite ends of said second support means and in spaced parallel relation to said first contact pair, whereby on application of flux said first contact pair touches said second contact pair when said first and second reeds are at said preselected distance from said operated position.

3. Apparatus in accordance with claim 2 further comprising means responsive to the further closure of said first and second reeds to said operated position for effecting rearward deflection of said first and second support means,

said first and second metallic contact pairs abutting with gradually increasing force during said further closure, thereby to reduce switch chatter.

4. Apparatus in accordance with claim 3 wherein said urging means comprises a first and a second reinforcement member abutting respectively said first and second support means to allow rearward deflection of said support means during said further closure and to prevent forward deflection of said support means after said first and second reeds have returned to said preselected distance from said operated position, thereby to prevent said first and second contact pairs from sticking.

5. Apparatus in accordance with claim 4 wherein said first and second reinforcement members include two end portions each which deliver to said support means an impact force upon the return of said first and second reeds to said preselected distance from said operated position, whereby said first and second contact pairs are abruptly separated.

6. Apparatus in accordance with claim 5 wherein said contact pairs are composed of gold.

7. An electrical switch comprising a gas-filled glass envelope, first and second flexible dry reeds supported in said envelope in normally spaced parallel relation thereby defining an open position of said switch, a magnetic third reed for applying magnetic flux and having an end portion overlapping into the space between said first and second reeds, contacting means responsive to application of said flux for making electrical contact between said first and second reeds when said last-named reeds have moved a preselected distance toward said third reed, said contacting means further responsive to removal of said flux for maintaining electrical contact between said first and said second reeds until said last-named reeds have moved said preselected distance away from said third reed.

8. Apparatus in accordance with claim 7 wherein said contacting means comprises a first normally straight support fixedly mounted on said first reed and a second normally straight support fixedly mounted on said second reed in juxtaposition to said first spring support, a first pair of metallic contacts mounted at opposite ends of said first support, a second pair of metallic contacts mounted at opposite ends of said second support and in normally spaced face-to-face relation to said first pair of metallic contacts, whereby on application of flux said first and second contact pairs touch before said first and second reeds contact said third reed.

9. Apparatus in accordance with claim 8 further comprising means responsive to the meeting of said first and second metallic contact pairs for effecting rearward reflection of said first and second support means, said contact pairs abutting with gradually increasing force until said first and second reeds contact said third reed, whereby the energy of impact between said contact pairs is gradually absorbed.

10. Apparatus in accordance with claim 9 further including a first reinforcement member mounted on said first support and a second reinforcement member mounted on said second support, said first and second reinforcement members allowing said first and second supports, respectively, to deflect rearwardly upon meeting of said contact pairs, and said first and second reinforcement members preventing any forward deflection of said first and second supports upon the removal of magnetic flux beyond their normal straight position, thereby to prevent sticking of said contact pairs.

11. Apparatus in accordance with claim 9 wherein said first and second reinforcement members have end portions which deliver respectively to said first and second supports an impact blow when said first and second reeds have moved said preselected distance away from said third reed, thereby to separate abruptly said first and second contact pairs.

12. Apparatus in accordance with claim 11 wherein said contacting pairs are composed of gold.

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BERNARD A. GILHEANY, *Primary Examiner.*

J. J. BAKER, *Assistant Examiner.*