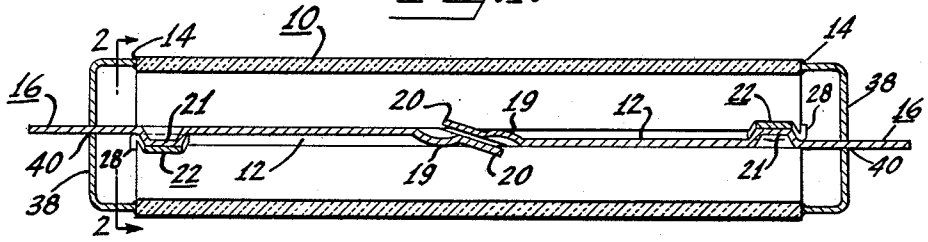
July 23, 1963 A. W. HEATH 3,098,908

REED SWITCH

Filed Dec. 28, 1961

Fig. 1.



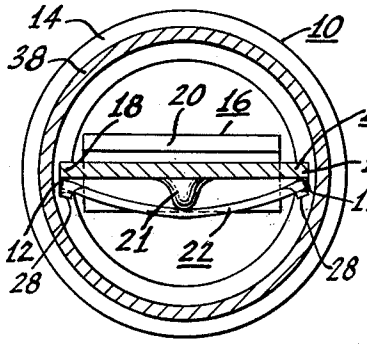




Fig. 2.

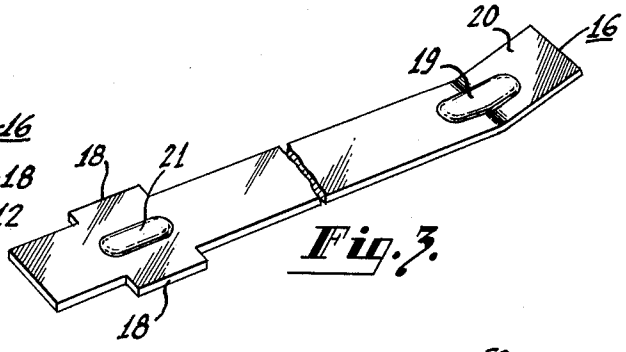



Fig. 3.

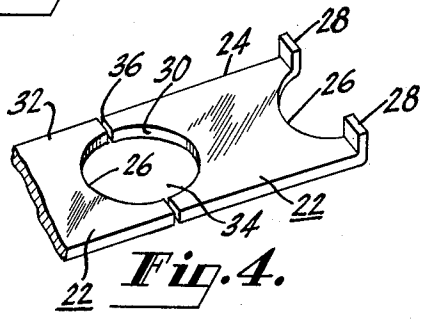



Fig. 4.

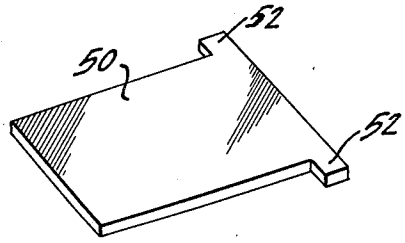



Fig. 6.

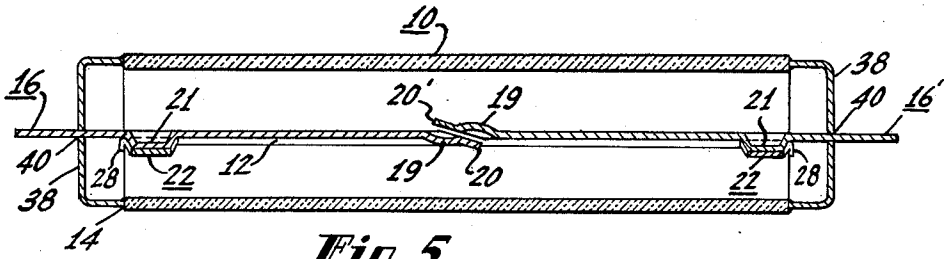



Fig. 5.

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3,098,908

# REED SWITCH

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7 Claims. (Cl. 200—87)

This invention relates to improved reed switches and particularly to the mounting of the reeds thereof in their enclosure.

Prior art reed switches includes two relatively thin strips or reeds of magnetic metal, each strip being sealed near one end thereof through an end of a short length of glass tubing or through a cap sealed to each end of a short length of ceramic tubing, which serves as an envelope. The inner ends of the reeds overlap slightly and are spaced a few thousandths of an inch apart, and are respectively cantilevered from points remote from the ends. The overlapping ends of the reeds are brought into contact by applying a magnetic field thereto of sufficient strength to cause movement of the ends toward each other until they touch. The outer ends act as terminals of the switch. One manner of applying an actuating magnetic field to a reed switch is to surround the switch by a coil and to pass a current through the coil. At a certain value of current through the coil, the magnetic field thereof will be great enough to cause the magnetic reeds to contact each other, closing a circuit in which the switch may be connected.

One major requirement in manufacture is that the gap and the amount of overlap of the inner ends of the reeds be accurately controlled. This is important in that for a given magnetic material and reed dimension, this gap and overlap determine the magnetic field required to operate the switch. It is important that this magnetic field be kept at a uniform value from switch to switch.

Glass envelopes for the switches introduce many problems relating to accurately locating the reeds with respect to each other, proper sealing and the like.

Ceramic materials, as distinguished from glass, have also been used in an effort to overcome the various problems encountered in the construction of reed switches. One of the most important problems is that the reeds be easily positioned in the course of manufacture, and that their final position be accurate and that such positioning be accomplished with economy. Each of these ceramic switches comprises a ceramic tube having at least one longitudinal groove therein. The reeds are fixed in the ceramic tubes with their adjacent ends overlapping and properly spaced by locking a wing or wings of the reeds in a groove or grooves in the ceramic tube. In one form of ceramic switch, the wings of the reeds fit the grooves tightly. In this form of switch, a proper fit of the reed wings in the slot can be achieved only if the ceramic and reed switch parts are held to fixed dimensions having tolerances somewhat closer than commercial tolerances. Such strict control of part dimensions requires undesirable costly procedures. A second form of ceramic reed switch includes a reed with only one wing and with a flat spring welded to the reed opposite its one wing and transversely to the reed. The wing enters a groove in the ceramic tube and the ends of the flat spring enters two other grooves in the ceramic tube. Such a reed switch construction requires the additional operation, in making them, of welding the flat spring to the reed. The extra welding operation adds cost to the switch and also may damage the resilient properties of the spring. A third form of the ceramic reed switch comprises reeds having two wings in opposite grooves of the ceramic tube, the wings extending into a folded-over spring, the lateral edges of which extend into the grooves and embrace the respective wings on the reed. Such a reed requires



provision of the folded-over spring of proper form and material. Also, it has been found in the assembly of such reed switches, that the folded-over spring assumes a position in the groove whereby the longitudinal dimension of the spring and of the groove form a slight angle, resulting in difficulty in inserting the reed through the slot in the folded-over spring and also in difficulty in inserting the spring into the grooves in the ceramic tube.

It is therefore an object of this invention to provide an improved ceramic reed switch.

It is an object of this invention to provide a ceramic reed switch involving improved cooperating reed and spring construction for holding the reeds in place in the ceramic enclosure.

It is an object to provide a ceramic reed switch of economical construction which is easy to assemble.

Generally speaking, the invention contemplates the provision of a longitudinal envelope of insulating material having at least one longitudinal groove in the inner wall thereof, at least one longitudinal reed having at least one wing remote from the ends thereof and extending laterally from the reed. The reed is embossed in a region adjacent the wing. A spring clip is provided. An edge portion of the clip and a wing of the reed are engaged in a groove with the embossed portion forcing a bowing of the spring clip so that the wing is securely cantilevered from the wing in the groove. The reed switch may be completed by placing caps of metal or metallized ceramic over ends of the reeds that extend out of the envelope and by brazing the caps to the previously metalized ends of the insulating enclosure.

Where it is desired to provide a normally closed switch or a latchable switch, the ceramic cylinder or tube may comprise a ferrite material which is permanently magnetizable or which has a high degree of magnetic retentivity.

The invention is described in detail in connection with the several figures of the drawing in which:

FIG. 1 is a longitudinal section of a reed switch made according to this invention;

FIG. 2 is a transverse section on line 2—2 of FIG. 1, and at an enlarged scale;

FIG. 3 is a perspective view of a reed used in the reed switch of this invention;

FIG. 4 is a perspective view of a spring clip used in the reed switch of this invention;

FIG. 5 is a longitudinal section of a modified reed switch; and,

FIG. 6 is a perspective view of a modified spring clip.

The reed switch of this invention comprises a relatively thin walled cylinder or tube **10** of ceramic material such as forsterite. The tube **10** is provided with two parallel slots or grooves **12** located opposite each other in the inside surface of the cylinder **10** and along the length thereof. The sides of the grooves **12** are parallel and the side of one groove is in the same plane as the corresponding side of the other groove. The grooves **12** are of the same height. The height of a groove is the distance between the two parallel walls of a groove **12**. The slots or grooves **12** extend the full length of the cylinder **10** so that the cylinder can be formed by a normal extrusion or isostatic process. Such processes produce cylinders having highly accurate and uniform dimensions whereby all cylinders are substantially uniform and the cross sectional dimensions of the cylinders are uniform along the lengths thereof. The ends of the cylinder are metalized at **14** in a known manner with a refractory metal such as molybdenum.

A pair of reeds **16** are provided, one reed extending into the cyinder **10** from each end thereof. Reeds **16** are identical. They are made of magnetic alloy, for example,

about 50% nickel and about 50% iron, known as "52 alloy." The reeds are of uniform thickness and of uniform width throughout most of their lengths. The reeds have oppositely directed wings 18 integral therewith for insertion into the grooves 12 in the cylinder 10, from which wings the reeds are cantilevered. The inner end of each reed 16 may be bent out of the plane of the remainder of the reed at a small angle, such as 8°, and for a short distance, for example, for from one to two times the width of the reed, as shown in FIGS. 1 and 3 at 20. If a bent reed is used, this angle of bend of the reed is important since the value of the magnetic field for closing the switch depends principally on the spacing and to a lesser extent on the overlap of the reeds. For example, the overlap may vary by plus or minus 20% from reed switch to reed switch while the spacing should be within plus or minus 5%. With a 7–9 degree angle, the ratio of change of spacing to overlap, as the reeds are moved towards each other is at an optimum value for quick, easy adjustment of the position of the reeds. If the angle of bend is greater, difficulty is experienced in adjusting the gap. If the angle of bend is smaller, upon adjustment of the gap, the overlap may be excessive. It is important that the reed angles in a particular switch be alike. The thickness of the reeds is substantially less than the height of the grooves in the cylinder for a purpose to be described.

The reed further comprises an embossed portion 19 at the bend thereof, the embossed portion 19 extending in the direction of the obtuse angle formed by the reed 16 and its bent-out portion 20. The purpose of this embossed portion 19 is to stiffen the bend between the main portion and the bent-up portion 20 of the reed 16 and to preserve the angle of the bend of the reed 16 during heat treatment sthat are applied to the reed switch in the brazing process while completing the switch. A further embossed portion 21 is formed in the reed 16 between the wings 18 of the reed 16. This embossed portion 21 is approximately equal in height to the thickness of the metal of the reed 16 and is approximately equal in width to twice the metal thickness and is approximately equal in length to the length of the widened or winged portion 18 of the reed 16. The length dimension of the embossed portion 21 preferably extends longitudinally of the reed 16. The purpose of this embossed portion will be made clear below.

The thickness of the reed 16 is substantially less than the height of the grooves 12, whereby upon insertion of the reed 16 only in a groove 12, the reed would be held loosely therein. A reed spring clip 22 is provided for holding each reed 16 in the grooves 12 of the cylinder 10. This spring clip 22 is shown in FIGS. 1, 2, 4 and 5. It comprises a flat piece 24 of resilient sheet metal, for example, an alloy known as "Inconel X." One end of the spring clip 22 is cut out in a curvilinear manner as shown at 26, leaving narrow end projections or tabs 28 which are each less than half the width of the spring clip. These tabs 28 are bent out of the plane of the remainder of the clip 22 at an angle, for example, of about 90°. As shown, a portion of the other end of the spring may be cut out as at 30. The extent of the cut-out portions 26 and 30 in the longitudinal direction of the spring clip 22 controls the lateral stiffness thereof. When making the spring clip from a continuous strip 32 of metal, the cut-outs 26 and 30 may result from the provision of a centrally positioned hole 34 in the strip 32. Thereafter, the strip 32 is cut perpendicular thereto and through the center of the hole 34, as at 36, to provide the tabs 28, which, in a later operation will be bent up to the position shown. The stiffness of the spring clip 22 is adjustably predetermined by the size and shape of the holes 34.

In assembling the reed switch of this invention, the flat spring clip 22 is inserted into an end of the tube 10 with the edge portions of the clip 22 in the groove 12 and with the tabbed end 28 of the spring clip 22 trailing. A reed 16 is inserted into the tube with the bent portion 20 leading, and the reed 16 contacting that side of the spring clip 22 away from the tabs 28, the boss 21 projecting from the side of the reed towards the spring clip 22. The wings 18 of the reed 16 are received in the grooves 12, the boss 21 contacting the clip 22, causing the flat clip 22 to bow out. The lateral edges of the clip 22 press against the winged portions 18 while an adjacent edge of each groove 12 presses against the clip. The clip is thereby caused to take a curved shape, it being flexed at each of its lines of contact with an edge of each groove 12 and with the boss 21. The reed 16 is thereby firmly held in position with its wings 18 in the grooves 12 by the resilience of the spring clip 22. The tabs 28 of the spring clip 22 hang over the end of the cylinder 10 and contact the end wall of the cylinder 10, thereby holding the clip 22 parallel to the length of the grooves 12. The pressure of the embossed portion 21 on the spring clip 22 also tends to turn the clip 22 about the axis of the cylinder 10 until each edge of the spring clip 22 contacts a wall of the groove 12. If the spring clip 22 is inserted in the groove 12 at an askew angle, one of the tabs 28 acts against the end of the tube 10, as the reed 16 is moved inwardly of the tube, to provide a fulcrum and the clip 22 turns about an axis perpendicular to the axis of the cylinder 10 and the major surfaces of the clip until both tabs 28 contact the end of the tube 10, thereby turning the clip 22 until it is parallel to the length of the cylinder 10. In their final position, the narrow edges of the bowed-out portion of the spring clip 22 contact the corners of the groove 12, as shown in FIG. 2.

The relative dimensions comprising the thickness of the wings 18, and the thickness of the spring clip 22 and the height of the slot 12 are such that were it not for bowing out or roof-like deformation of the spring clip 22 produced therein by the boss 21 of the reed 16, the spring clip 22 and the reed 16 would slide into the groove 12 readily with one or two mils clearance. However, upon bowing out of the spring clip 22 by boss 21, the spring 22 and the reed 16 more than take up this clearance. Therefore, the edges of groove 12 press on the bowed spring clip 22 and tend to flatten it. The spring clip 22 resiliently resists this flattening pressure and therefore, spring pressure is exerted on one side of both of the wings 18 and for substantially their whole length, in such a way as to press the other sides of the reed wings 18 against the opposite sides of the grooves 12, properly positioning a reed in the grooves. The other reed 16 and clip 22 are inserted in the other end of the tube 10 with the clip 22 pressing the wings 18 of the reed 16 against the other sides of the slot 12 as shown in FIG. 1, whereby the two reeds 16 are referred to opposite surfaces of the groove 12.

The present skill in forming ceramic tubes with slots therein is sufficient to provide slots straight enough and of sufficiently uniform dimensions so that even though the reeds are referred to opposite walls (for example, the upper and lower walls as viewed in FIG. 1) of the slots 12, upon final adjustment of the position of the reeds, as will be explained, reed switches of substantially uniform characteristics are produced. The use of the spring clips 22 not only makes for positive reed location but also permits the use of reed wings 18 and ceramic slots 12 having dimensional tolerances which are readily achieved with known ceramic and metal working technology. Another advantage of the spring clip 22 is realized when the spring clip 22 is narrower than the wing to wing dimension of the reed 18. Any unavoidable burr produced in making the reeds 16, if directed towards the clip 22 in the final assembly of the reed switch, will neither contact the groove wall nor the clip 22, since the burrs on the reed will extend along either side of the clip and any burr on the clip 22 if directed away from

the reed **16** will neither contact the reed wings **18** nor the other wall of the groove **12** since the edges of the clip do not contact the walls of the groove. In a reed switch in which the position of the reeds must be accurate, this avoidance of error induced by presence of burrs is an important advantage.

If it be desired to refer the reeds **16** to the same side of the groove **12** in the ceramic tube **10**, and if bent reeds are used, reeds may be provided in pairs. In one reed **16** of the pair, the embossed portion **21** between the wings **18** is directed towards the bent-up portion of the reed **20**, as shown in FIG. 3 and in FIG. 5. The other reed **16'** of the pair of reeds is formed with the bent-up portion **20'** directed away from the boss **21** between the wings **18**, the reed **16'** being shown in FIG. 5. The reeds **16** and **16'** are inserted in the ceramic cylinder **10** with the bent portions **20** and **20'** towards each other and parallel to each other, and with one side of each reed **16** and **16'** in contact with the same side of the groove **12** in the cylinder **10**, shown in FIG. 5 as the upper side, the spring clips **22** being between the reeds **16** and **16'** at the respective wing portions thereof and the other walls of the grooves **12**. While such a reed switch requires two different reeds **16** and **16'**, in the resultant reed switch, the reeds **16** and **16'** are referred to the same wall of the groove **12**. Otherwise the reed switches of FIGS. 1 and 2 and of FIG. 5 do not differ.

A modified spring clip **50** is shown in FIG. 6. This spring clip **50** comprises a flat spring having laterally extending tabs **52**. This spring clip **50** is used like spring clip **22**, that is, the lateral edges of the spring clip are received in the grooves **12** with the tabs **52** contacting the ends of the cylinder **10**. The clip **50** may be formed from flat spring sheet by stamping out the desired form in a known manner. Or tabs may be produced on a spring clip of uniform width by pinching two adjacent end corners thereof, whereby metal flows laterally to produce tabs. The tabs of all embodiments of the clip extend far enough to contact the end of the tube in the tabs' assembled position.

In adjusting the reeds in either the reed switch of FIGS. 1 and 2 or of FIG. 5, to their final position, the cylinders having a pair of reeds and a pair of clips therein are inserted into a magnetic field, and the reeds are moved towards each other until the inner ends of the reeds make electric contact. In the final position, the contacting portions of the reeds are preferably centralized along the length of the tube **10**.

The reed switch enclosure is next completed. The completed reed switch enclosure includes end closures **38**. The end closures **38** shown in FIGS. 1 and 5, comprise metal cups, each having slots **40** therethrough through which the outer ends of the reeds **16** extend. In the completed reed switch, the caps or end closures **38** are brazed to the metalized surfaces **14** of the cylinders **10** and to the reeds **16** at the contacting portion thereof, to form a vacuum-tight sealed structure. The internal atmosphere of the reed switch may be argon, neon, helium or any inert gas or the enclosure may be evacuated. Preferably, however, an atmosphere of or including hydrogen is provided in the manufacture of the reed switch.

If it be desired to provide a reed switch of the normally closed type, the cylinder may comprise a magnetic ferrite ceramic material in which a remaining magnetic field may be induced by applying a magnetic field thereto. To open this closed type switch, this remaining field may be neutralized, but without destroying it, by applying a magnetic field in the opposite direction. If a latching type switch is to be produced, the cylinder may comprise a magnetic ceramic material in which the remaining magnetic field in the cylinders may be changed by the switch operating field. That is, the field that closes the switch may induce a field in the cylinder that keeps the switch closed, while the field that opens the switch may destroy the closing field in the cylinder whereby the switch remains open.



As noted above, reeds which are like the reed shown in FIG. 3 except that they are straight and are embossed only at **21** between the wings **18**, may be used. Such reeds are inserted into grooves **12** of tube **10** and are held therein by clips **22** or **50** like the bent reeds mentioned above. The inner ends of straight reeds may overlap like the bent reeds.

What is claimed is:

1. A reed switch comprising:
(*a*) an envelope having side walls with a pair of opposed grooves internally thereof,
(*b*) a flat switch reed having a longitudinal axis, a pair of opposed wings on each side of said axis, and an embossed portion substantially between said wings,
(*c*) a spring clip having a pair of opposed edges,
(*d*) said wings and said edges being engaged in said grooves with the said embossed portion pressed against said spring clip and thereby forcing a bowing of said spring clip away from said reed,
whereby the reed is securely cantilevered in the grooves.

2. A reed switch comprising:
(*a*) a tubular envelope of refractory insulating material,
(*b*) having at least one longitudinal internal groove in the wall thereof,
(*c*) a pair of reeds,
(*d*) each reed projecting into said tubular envelope to such an extent that the inner ends of the reeds are adjacent each other,
(*e*) a portion of each reed extending into a groove,
(*f*) said reeds being embossed in the region adjacent said portion thereof,
(*g*) a spring clip,
(*h*) said clip being positioned in said tubular envelope so that one surface thereof contacts the embossed region of a reed and another portion of said spring clip is in said groove of said envelope.

3. A reed switch comprising:
(*a*) a tubular envelope of insulating material,
(*b*) having a pair of longitudinal grooves in the inner wall thereof,
(*c*) a pair of reeds, at least one of said reeds having wings extending into said grooves,
(*d*) said reeds projecting into said tubular envelope to the extent that the inner ends of the reeds are adjacent each other,
(*e*) said one reed being embossed in a region between its wings,
(*f*) a spring clip having edge portions extending into said grooves,
(*g*) said spring clip contacting said embossed portion.

4. A reed switch comprising:
(*a*) a refractory non-conductive tubing,
(*b*) having at least two internal grooves extending longitudinally thereof,
(*c*) a pair of reeds of magnetic material having wing portions projecting into said grooves,
(*d*) said reeds projecting into said tubing to the extent that the inner ends of the reeds are adjacent each other,
(*e*) a portion of at least one of said reeds being embossed in the region thereof between said wings,
(*f*) a spring clip having a substantially flat portion when unstressed and a pair of tabs extending from said flat portion,
(*g*) said spring clip being so positioned that edge portions thereof extend into said grooves and portions thereof between said edge portions contact said embossed portion,
(*h*) said tabs extending out of said grooves and beyond an end of said tubing.

5. A reed switch comprising:
(*a*) a refractory non-conductive tubing having at

least two internal grooves extending longitudinally thereof,

(*b*) a pair of reeds of magnetic material having portions thereof extending into said grooves,

(*c*) said reeds projecting into said tubing to the extent that the inner ends of the reeds are adjacent each other,

(*d*) a portion of at least one of said reeds being embossed between the said extending portions,

(*e*) a spring clip having a substantially flat body when unstressed,

(*f*) said clip being positioned so that its edges are in the grooves and a portion of the clip between the grooves is in contact with said embossed portion,

(*g*) the thickness of the reed and clip and the extent of the embossment being so related to the groove dimension that the spring contacts a portion of each groove and said embossed portion and is bowed by such contacts.

6. A reed switch comprising:

(*a*) a refractory non-conductive tubing having at least two internal grooves having parallel walls and extending longitudinally thereof,

(*b*) a pair of reeds of magnetic material having portions thereof extending into said grooves,

(*c*) said reeds projecting into said tubing to the extent that the inner ends thereof are adjacent each other,

(*d*) a portion of at least one of said reeds being embossed between said extending portions,

(*e*) a spring clip having a substantially flat body when unstressed and tabs extending from one end of said body,

(*f*) said clip being positioned so that its edges are in the grooves and so that a portion of the clip between the grooves contacts said embossed portion,

(*g*) the thickness of the reed and of the clips and and the extent of the embossment being so related to the distance between the parallel walls of the groove that the clip contacts a portion of each



groove and said embossed portion, whereby said clip is bowed by said contact,

(*h*) said tabs extending beyond the end of said tube and adjacent an end thereof.

7. A reed switch comprising:

(*a*) a refractory non-conductive tubing having at least two internal grooves having parallel walls and extending longitudinally thereof,

(*b*) a pair of reeds of magnetic material having portions thereof extending into said grooves,

(*c*) said reeds projecting into said tubing to the extent that the inner ends thereof are adjacent each other,

(*d*) a portion of at least one of said reeds being embossed between said extending portions,

(*e*) a spring clip having a substantially flat body when unstressed and tabs extending from one end of said body,

(*f*) said clip being positioned so that its edges are in the grooves and so that a portion of the clip between the grooves contacts said embossed portions,

(*g*) the thickness of the reed and of the clips and the extent of the embossment being so related to the distance between the parallel walls of the groove that the clip contacts a portion of each groove and said embossed portion, whereby said clip is bowed by said contact,

(*h*) said tabs extending beyond the end of said tube and adjacent an end thereof,

(*i*) the extreme width of the reed at the portion thereof which extends into the grooves being wider than the lateral extent of said clip when in bowed condition.

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