

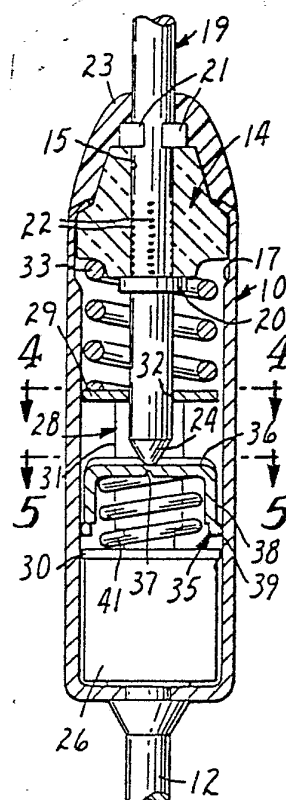
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(54) Title: THERMAL SWITCH

(57) Abstract

In a single use thermal switch having a fusible pellet that melts at a predetermined temperature and utilizing a slidable contact member, it would be most desirable if the contact member could easily slide in the casing when disconnecting the circuit. A thermal switch incorporates a mechanical isolation cage (28) which is axially movable. The cage is normally urged by a helical compression spring (33) against a fusible pellet (26) which melts at a temperature at which it is desired to disconnect the electrical circuit. An electrically conductive contact member (35) extending transversely through the isolation cage is normally urged by a helical compression spring (41) toward one end of the cage and against the end of one electrical lead (19) that is coaxial with the casing (10). The contact member is foldable along a line across its center. The force of the contact member pressed against the end (24) of the lead urges the contact member to fold to cause the ends thereof to be forced against the inside wall of the casing to establish electrical connection between the casing and the lead through the contact member. The thermal switch is utilized in small home appliances subject to overheating upon failure.



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THERMAL SWITCHField of the Invention

The present invention relates to a single use thermal switch having a fusible pellet that melts at a predetermined temperature permitting an electrical contact member to move to break the electrical circuit.

Background Art

The prior art includes a number of different configurations for single use or one shot thermal switches having fusible pellets that melt at a predetermined temperature, as illustrated by U.S. Patents Nos. 3,180,958; 3,281,559; 3,519,972; 3,924,218; 4,060,787; 4,068,204; 4,145,654; 4,246,561 and 4,246,564. Several million switches of the type illustrated in Figures 1-6 of U.S. Patent No. 3,519,972 and in U.S. Patent No. 4,060,787 are utilized each year in small home appliances subject to overheating upon failure, such as coffee makers and hair dryers. These most popular designs, and several of the others, utilize a contact member that is axially slidable within the tubular casing and has a resilient periphery that contacts the inside wall of the casing with a constant radial force. The contact member normally contacts the end of the insulated lead to complete the circuit from the case through the contact element to the lead and upon melting of the fusible pellet the disc is pushed away from the lead to disconnect the circuit. This design has proven highly reliable when the parts are within tolerance and are properly assembled within the switch. However, since the pressure exerted by the periphery of the contact member against the casing is only necessary to reliably complete the electrical connection in the normal state, it would be most desirable if that force would diminish when the temperature was reached at which it was desired to open the circuit so that the contact member could more easily slide in the casing to move away from the electrical lead and disconnect the circuit.

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Disclosure of Invention

The present invention provides a thermal switch having a tubular, electrically and thermally conductive metal casing. A first electrically conductive lead is joined to and extends from one end of the metal case to seal off the end and make electrical connection to the casing. An insulative ceramic bushing at the opposite end of the casing, has its bore coaxial with the casing and seals the end of the casing. A second electrically conductive lead extends into the casing through the bore of the ceramic bushing and out of the casing to insulate the lead from the casing and to permit electrical connection thereto outside the casing. A normally solid, fusible pellet is within the casing adjacent the one end. A mechanical isolation cage is within the casing and has first and second parallel ends perpendicular to the axis of the casing, the cage being axially slidable within the casing and having a central opening in its first end through which the second lead normally freely passes. A first helical compression spring is between the ceramic bushing and the first end of the cage and urges the cage against the fusible pellet. An electrically conductive contact member extends through the cage in a direction perpendicular to the axis of the casing and has its ends terminating in close proximity to the side walls of the casing. The contact member is foldable along a line across its center and has a portion to each side of its center that has a component perpendicular to the axis of the casing and a component parallel to the axis of the casing. A second helical compression spring is between the second end of the cage and the contact member and presses the contact member against the end of the second lead to cause the contact member to fold until its ends contact the side wall of the casing.

The pressure of the second helical compression spring forcing the contact member against the second lead and the resulting folding of the contact member forceably



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presses the ends of the contact member against the side wall of the casing to establish reliable electrical contact from the casing through the contact member to the insulated lead. When the fusible pellet is melted the mechanical isolation cage is moved axially by the first compression spring until it contacts the contact member at which time it carries the contact member away from the second lead immediately relieving the force between the lead and the contact member and thereby diminishing the pressure of the ends of the contact member against the side wall of the casing to permit the contact member to be more easily slid axially down the casing to break the electrical contact.

Brief Description of the Drawing

In the Drawing, Figure 1 is a longitudinal cross-sectional view of a thermal switch constructed in accordance with the present invention in its normal state as manufactured; Figure 2 is a view similar to that of Figure 1 after the pellet has partially melted or sublimed; Figure 3 is a view similar to that of Figures 1 and 2 after the pellet has melted and the circuit has been disconnected; Figure 4 is a transverse cross-sectional view taken along line 4-4 of Figure 1; Figure 5 is a transverse cross-sectional view taken along line 5-5 of Figure 1; and Figure 6 is an exploded isometric view of the thermal switch illustrating the parts thereof.

Best Mode for Carrying Out the Invention

The thermal switch of the present invention has a tubular, electrically and thermally conductive metal casing 10. A first electrically conductive lead 12 is joined to and extends from one end of the metal casing to seal off the end and make electrical connection to the casing. In the illustrated embodiment the end of the casing is bent perpendicular to its axis and the lead 12 is swaged or riveted to the casing 10.

An insulative ceramic bushing 14 seals the



opposite end of the casing 10 and has its bore 15 coaxial with the casing. The bushing 14 is retained in place in the casing 10 between a shoulder 17 on the inner wall of the casing 10 and the end of the casing which is bent over the end of the bushing 14 during assembly. A second electrically conductive lead 19 extends into the casing 10 through the bore 15 of the ceramic bushing 14 and out of the casing to insulate the lead from the casing and to permit electrical connection to its exposed end. The second lead 19 is formed with an enlarged ring 20 to abut the inner surface of the ceramic bushing 14. A pair of ears 21 are formed on the second lead 19 adjacent the outer end of the bushing 14 after insertion of the lead through the bushing to prevent the lead from movement axially with respect to the bushing. The ears are each formed starting generally at less than a third of the diameter of the undeformed lead 19 so as not to unduly weaken this portion of the lead in bending. Radial indentations 22 are formed in the second lead 19 in the area within the bushing 14 and a sealing resin 23 is applied over the end of the ceramic bushing to seal the end of the switch. A portion of the resin seeps down the bore 15 of the ceramic bushing 14 and into the indentations 22 in the lead 19 and when the resin hardens in the indentations 22 it aids in preventing twisting of the lead 19 as described in U.S. Patent No. 4,060,787. The end 24 of the lead 19 within the casing 10 has a truncated conical shape for a purpose which will be hereinafter described.

A normally solid, fusible pellet 26 is positioned within the casing 10 adjacent the end having the first lead 12. The fusible pellet 26 is chosen to have a melting temperature corresponding to a temperature that indicates failure of the electrical device in which the thermal switch is to be used.

A mechanical isolation cage 28 is axially slidable within the casing 10. The cage 28 has disc-shaped parallel ends 29 and 30 joined by opposed arcuate edge

strips 31. The cage 28 is formed from a strip of metal with the upper end 29 being at the center of the strip and the ends of the strip each forming a half circle and being bent toward each other to define the lower end 30 of the cage 28. The upper end 29 of the cage 28 is formed with a central aperture 32 through which the second lead 19 freely passes. A first helical compression spring 33 between the ceramic bushing 14 and the first or upper end 29 of the cage 28 urges the cage against the fusible pellet 26.

An electrically conductive contact member in the form of a cup 35 extends transversely through and is coaxial with the cage 28. The cup has a bridge piece 36 perpendicular to the axis of the casing 10 which is foldable along a line 37 across its center. The fold line 37 is created by a V-shaped reduction in the thickness of the material of the bridge 36 from the lower surface of the bridge. The cup has an arcuate side wall 38 at each end of the bridge 36 extending generally parallel to the axis of the casing 10 from the bridge toward the second or lower end 30 of the cage 28 in close proximity to the side wall of the casing 10. The free ends of the side walls 38 of the cup 35 are formed with radially protruding rounded edges 39 for contacting the side wall of the casing 10. A second helical compression spring 41 is between the second or lower end 30 of the cage 28 and the bridge 36 of the cup 35 and presses the center of the bridge 36 against the end 24 of the second lead 19.

The contact member may be shaped other than in the illustrated cup configuration. For example, it may be a straight piece with arcuate ends for contacting the inner wall of the casing folded along its center fold line so that in a longitudinal cross-sectional view through the switch it would appear V-shaped. The portion of the contact member to each side of the fold line would then have components both perpendicular and parallel to the axis of the casing 10 even though not represented by distinct parts as the bridge 36 and side wall 38 in the illustrated



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embodiment.

5 In normal use, the ends of the leads 12 and 19 are connected into an electrical circuit of a device which is to be protected against overheating. The switch will normally appear as in Figure 1 with the conductive contact cup 35 pressed against the end 24 of the second lead 19. The truncated conical shape of the end 24 of the lead 19 concentrates the force applied by the lead 19 to the bridge 36 because of the opposed force of the spring 41 to the fold line 37 of the bridge 36. This concentrated force causes the bridge to fold downward on fold line 37 causing the arcuate side walls 38 of the cup 35 to tilt outward until the rounded edges 39 thereof press against the side wall of the casing 10. The contact force of the edges 39 of the cup 35 with the casing 10 can be adjusted by proper choice of the spring 41. The contact force must be sufficiently high to produce a reliable electrical connection through the cup 35 so that electricity can normally flow between the leads 12 and 19 through the casing 10 and the cup 35.

One problem with available normally solid, fusible materials in current use is that over a period of time they will to a certain extent sublime and shrink even under normal conditions. As can be seen in Figure 2, in the switch of the present invention even though the pellet 26 has shrunk, the contact cup 35 continues to be pressed against the second lead 19 to maintain the electrical circuit. Though the upper spring 33 extends and pushes the cage 28 downward following the pellet, the lower spring 41 also extends to accommodate the shrinkage of the pellet. When the predetermined melting temperature of the pellet 26 is reached the pellet very quickly melts and the upper spring 33 moves the cage 28 downward. The lower spring 41 continues to expand until the contact cup 35 comes into contact with the upper end 29 of the cage 28. After this point is reached the lower spring 41 exerts no further force that is transmitted to the second lead 19. Thus, the

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pressure is relieved at the fold line 37 of the cup 35 thereby removing the force pressing the edges 39 of the side walls 38 against the side wall of the casing 10. Continued movement of the cage 28 downward by the spring 33 thus carries the cup 35 downward with it breaking the electrical connection to the second lead 19. The contact pressure having been removed from the cup, it readily slides downward with the cage 28.



CLAIMS

1. A thermal switch having a tubular,
electrically and thermally conductive metal casing (10), a
first electrically conductive lead (12) joined to and
5 extending from one end of said metal casing to seal off
said one end and make electrical connection to said casing,
an insulative ceramic bushing (14) at the opposite end of
said casing, said bushing sealing the opposite end of said
casing and having its bore (15) coaxial with said casing, a
10 second electrically conductive lead (19) extending into
said casing through the bore of said ceramic bushing and
out of said casing to permit electrical connection thereto,
a normally solid, fusible pellet (26) within said casing
adjacent said one end, a pair of helical compression
15 springs (33, 41) and a contact member (35) slidable with
said casing and urged by said springs to normally make
electrical contact to said casing and said second lead and
to be moved away from said second lead upon melting of said
pellet, characterized in that a mechanical isolation cage
20 (28) is within said casing and has first and second
parallel ends (29, 30) perpendicular to the axis of said
casing, said cage being axially slidable within said casing
and having a central opening (32) in its first end,
adjacent said opposite end of said casing, through which
25 said second lead normally freely passes, said first helical
compression spring (33) is between said ceramic bushing and
said first end of said cage and urges said cage against
said fusible pellet, said electrically conductive contact
member (35) extends through said cage in a direction
30 perpendicular to the axis of said casing and has its ends
terminating in close proximity to the side walls of said
casing, said contact member being foldable along a line
(37) across its center and having a portion to each side
of its center that has a component (36) perpendicular to
35 the axis of said casing and a component (38) parallel to
the axis of said casing, and said second helical

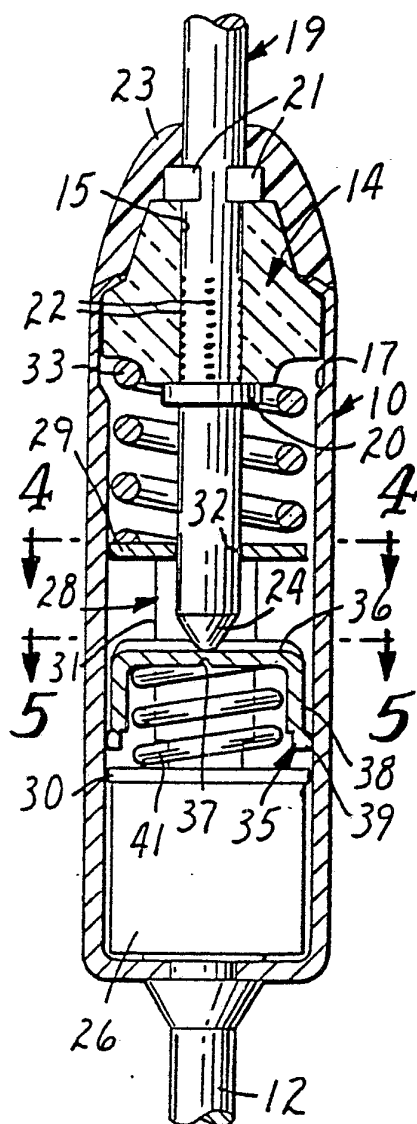
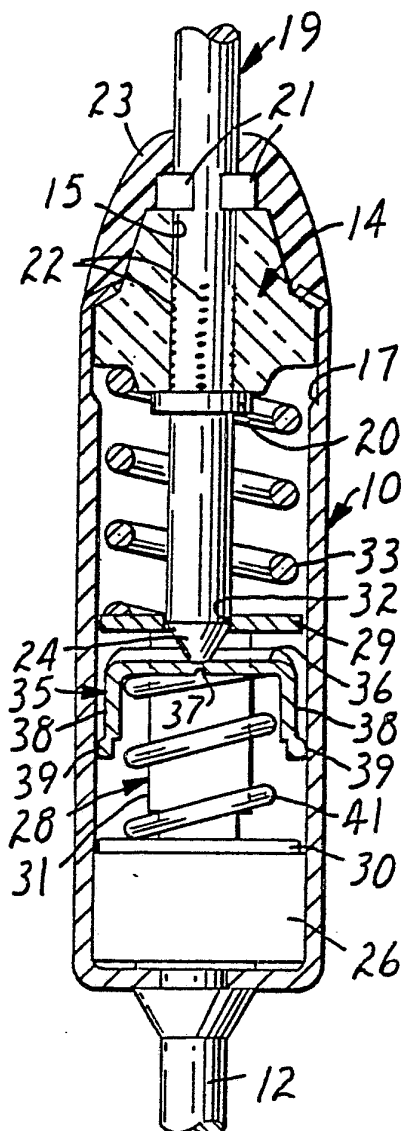
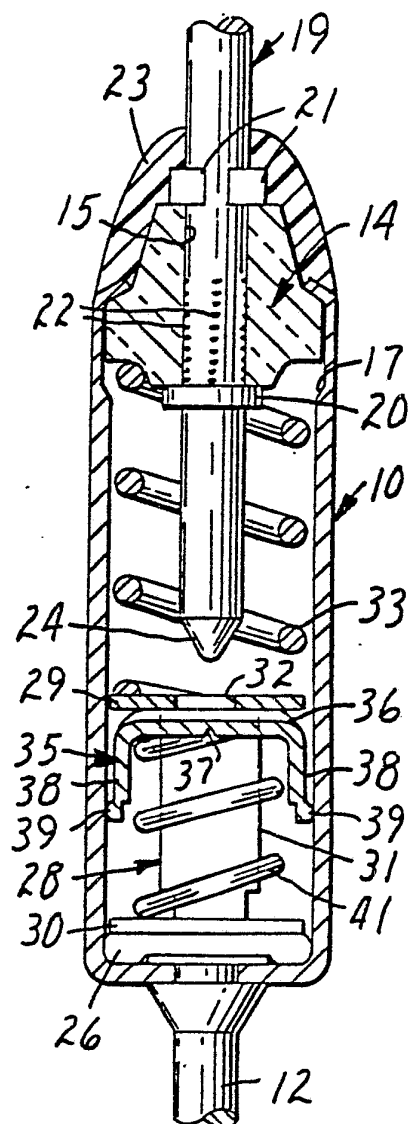
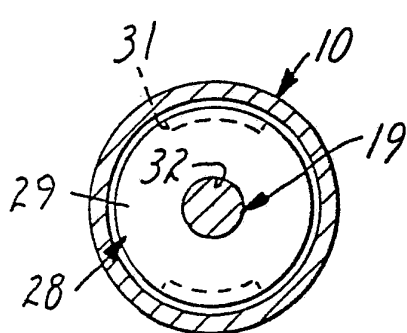
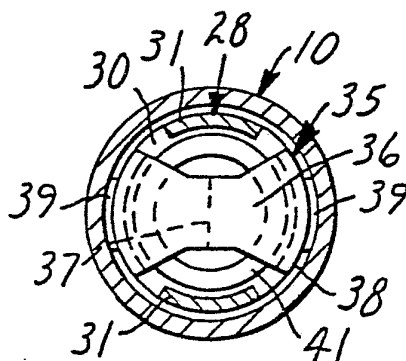


compression spring (41) is between said second end of said cage and said contact member and presses said contact member against the end of said second lead to cause said contact member to fold until its ends contact the side wall of said casing.

2. The thermal switch of claim 1 characterized in that said contact member (35) comprises a contact cup having a bridge piece (36) perpendicular to the axis of said casing which is foldable along a line (37) across its center and an arcuate side wall (38) at each end of said bridge extending generally parallel to the axis of said casing from said bridge toward said second end of said cage in close proximity to the side wall of said casing, and wherein said second helical compression spring (41) presses the center of said bridge against the end of said second lead.

3. The thermal switch of claim 2 characterized in that the free ends of said arcuate side walls (38) of said electrically conductive cup are formed with radially protruding rounded edges (39) for contacting the side wall of said casing.

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**FIG. 1****FIG. 2****FIG. 3****FIG. 4****FIG. 5**

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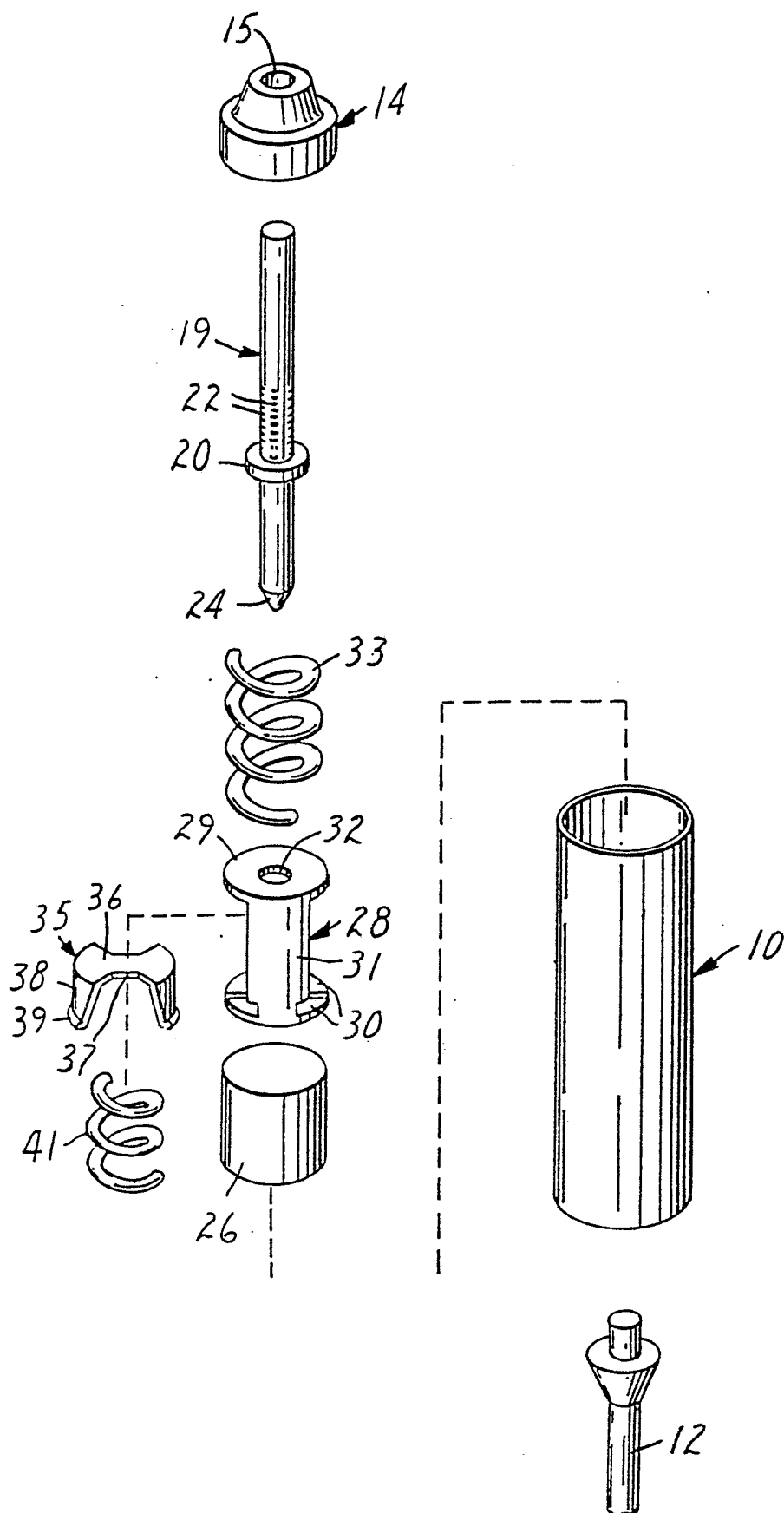


FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US83/00212

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT. CL ³ H01H 37/76		
US CLASS 337/408		
II. FIELDS SEARCHED		
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Classification System	Classification Symbols	
US	337/407, 408, 409	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
A	US, A 4,109,229 PUBLISHED 22 August 1978	1-3
A	US, A 4,246,564 PUBLISHED 20 Jan 1981	1-3
A	US, A 4,276,531 PUBLISHED 30 June 1981	1-3
* Special categories of cited documents: ¹⁵ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ²	Date of Mailing of this International Search Report ³	
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International Searching Authority ¹	Signature of Authorized Officer ¹⁰	
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See notes on accompanying sheet