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Them

[11] **3,715,697**

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[54] **THERMAL FUSE**

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[52] **U.S. Cl.** **337/157,** 337/3, 337/333

[51] **Int. Cl.**.....**H01h 37/00**

[58] **Field of Search**.....337/157, 3, 333, 354, 346

[56] **References Cited**

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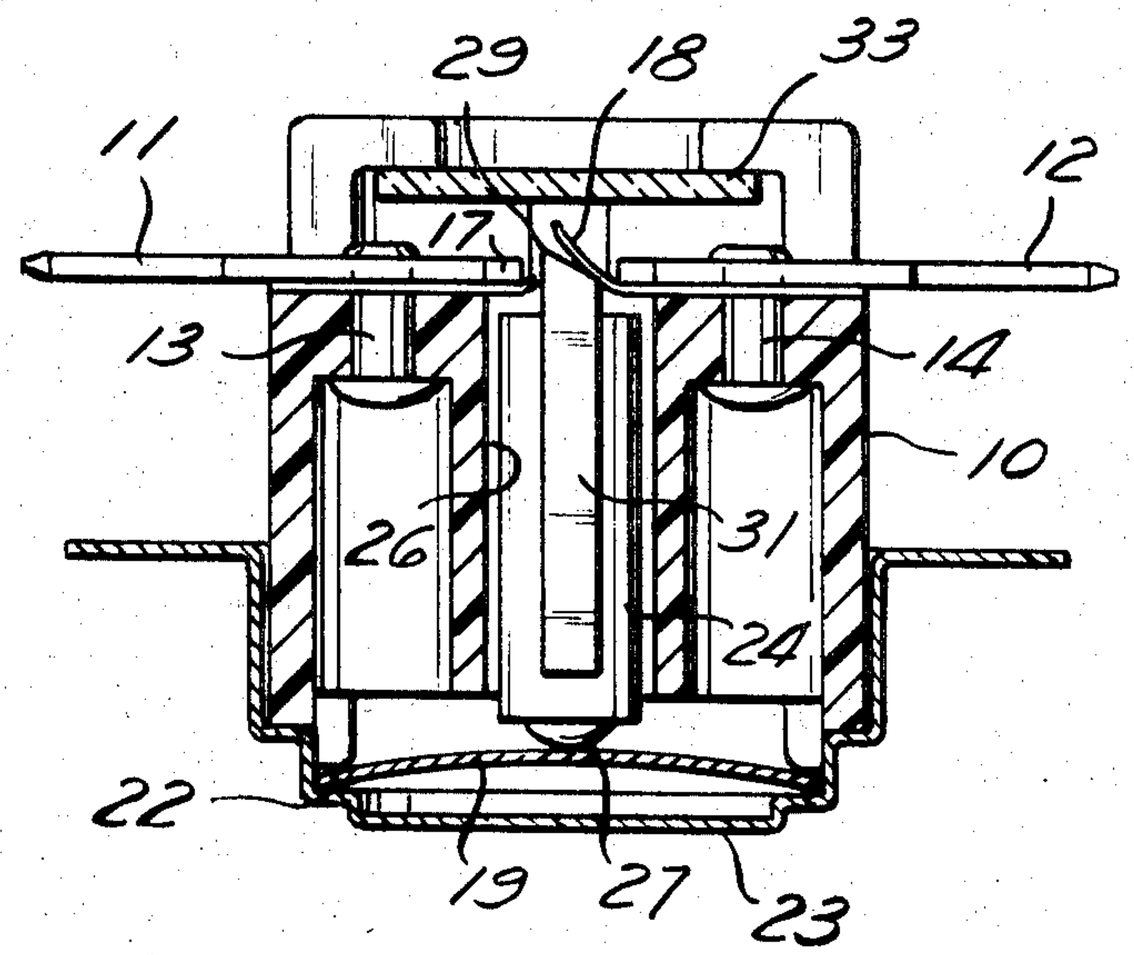
Assistant Examiner—F. E. Bell
Attorney—McNenny et al.

[57] **ABSTRACT**

A thermal fuse is disclosed in which a bimetallic snap disc operates an elongated cutter causing the cutter to engage and rupture a thin metal conductor. Terminal elements provided with sawtooth-like teeth engage the side of the conductor opposite the cutter to provide points of high localized stress which facilitate the cutting or rupturing operation.

13 Claims, 5 Drawing Figures



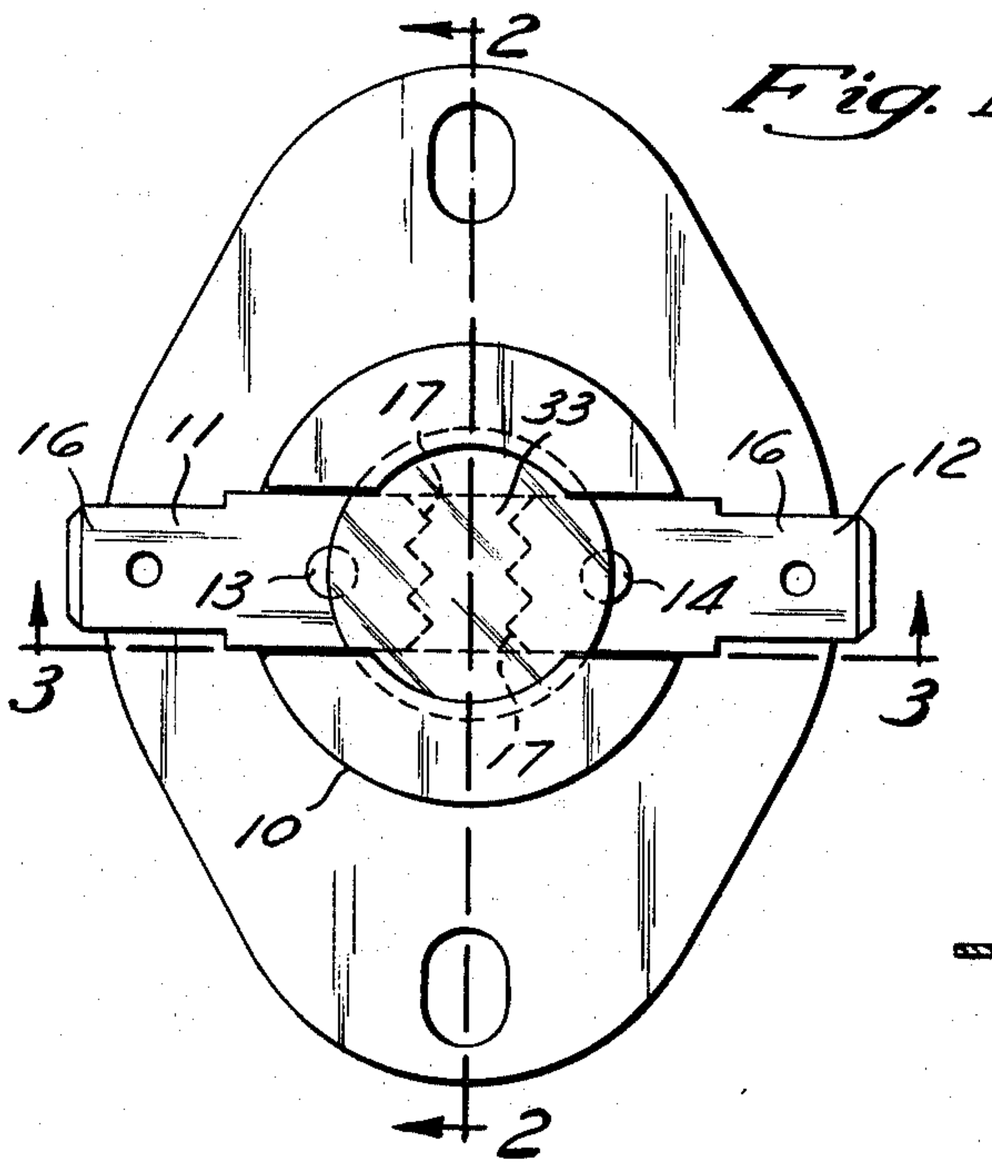


Fig. 1

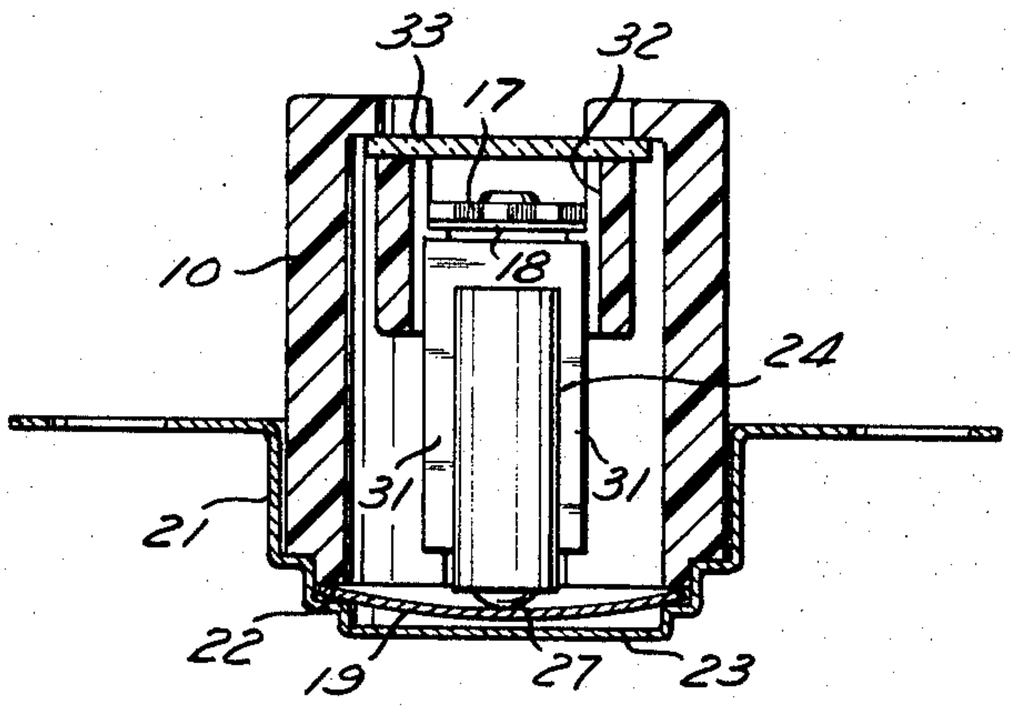


Fig. 2

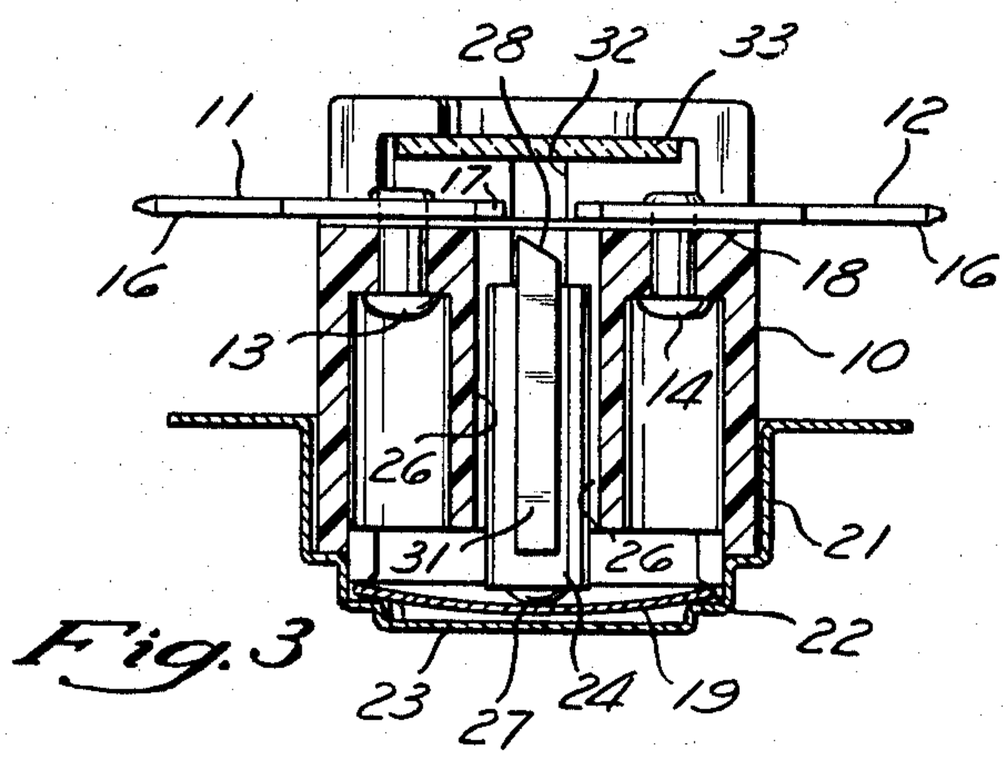


Fig. 3

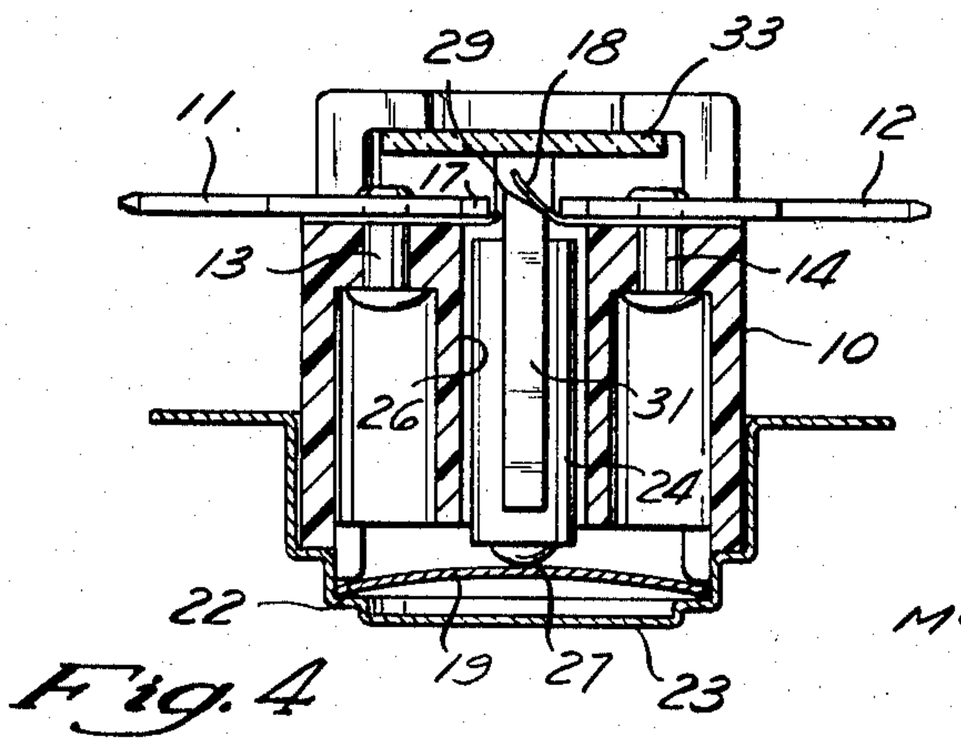
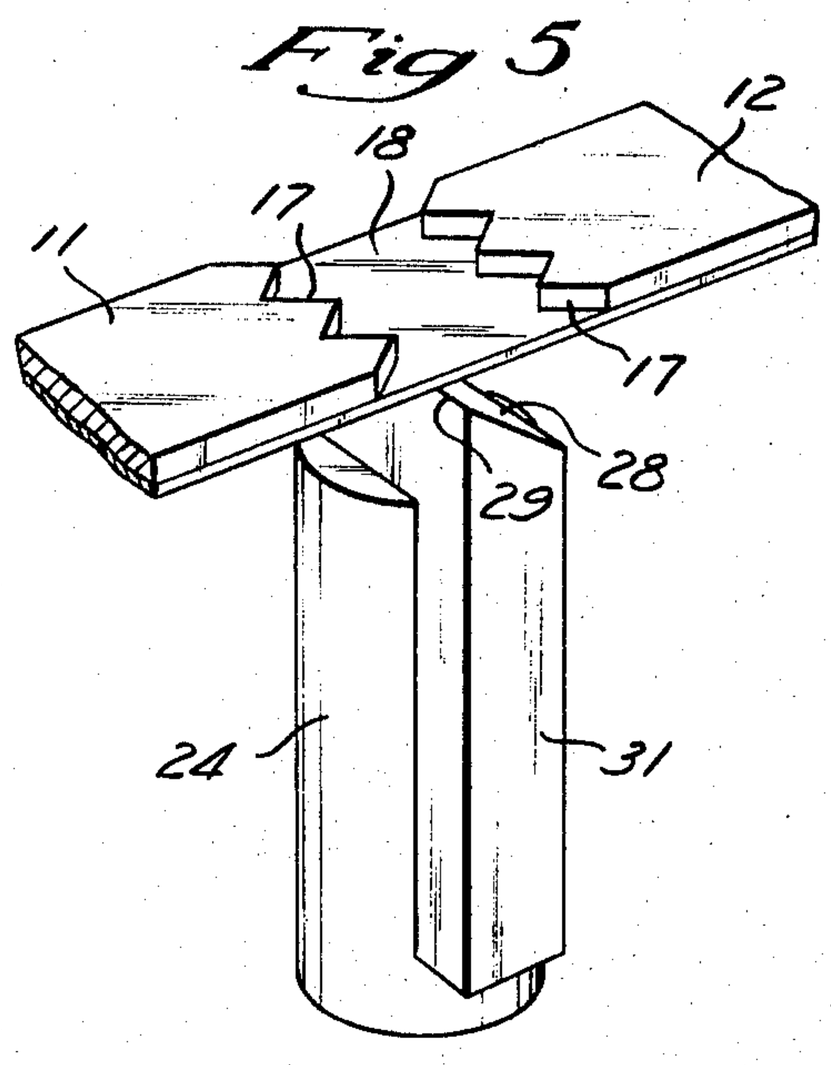


Fig. 4

Fig 5



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THERMAL FUSE

BACKGROUND OF THE INVENTION

This invention relates generally to fuse devices and more particularly to a temperature-responsive fuse having a frangible element which is ruptured to break a circuit when a predetermined temperature exists.

PRIOR ART

Electrical fuse devices are often employed to break a circuit when a predetermined condition is reached in which damage to the system may occur or dangerous conditions may prevail. In many instances, the fuses are current-responsive. Such fuses, when the condition to be sensed is current flow, normally employ a conductor which melts when a predetermined current is carried thereby. In other instances, fuses are employed which are not sensitive to current flow, but rather to temperature. Such fuses often are provided with a material which melts at a given temperature and causes a circuit to be broken. An example of such a fuse is illustrated in the United States Letters Patent Number 3,155,800.

SUMMARY OF THE INVENTION

A fuse in accordance with the present invention employs a frangible conductor in combination with a condition-responsive mechanism which operates to rupture the conductor and break the circuit when a predetermined condition occurs. In the illustrated embodiment, the fuse is temperature-responsive and utilizes a bimetallic snap disc to actuate a cutter element which functions to cut a conductor and break the circuit. Such device provides reliability and low cost because of its simplicity.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of a thermal fuse incorporating the present invention;

FIG. **2** is a cross section taken generally along **2—2** of FIG. **1**;

FIG. **3** is a cross section taken generally along **3—3** of FIG. **1** illustrating the mechanism before operation;

FIG. **4** is a view similar to FIG. **3**, but illustrating the mechanism after operation; and

FIG. **5** is an enlarged fragmentary perspective view illustrating the conductor and cutter member prior to the operation of the device.

DETAILED DESCRIPTION OF THE DRAWINGS

The illustrated embodiment of this invention is provided with a base **10** preferably molded from a non-conducting material such as a phenolic resin. First and second terminal elements **11** and **12** are secured to the body **10** by rivets **13** and **14**. The two terminal elements **11** and **12** are identical in shape and are each provided with end portions **16** adapted to be connected to the leads in a system to be protected by the device. The inner ends of each terminal element is serrated to provide a plurality of sawtooth shaped teeth **17** extending thereacross. In the illustrated embodiment, each terminal is provided with three teeth. A thin conductor strip **18** extends between the two terminals **11** and **12** and provides an electrical connection therebetween. The strip **18** is sized to extend along each of the terminals and is secured to the terminals at its ends by the rivets **13** and **14** which press the ends of the conductor strip **18** between the terminals and the adjacent surface of the body **10**.

Thermal-responsive means are provided to rupture the conductor strip **18** when a predetermined temperature condition is reached. Such means include a bimetallic snap disc **19** and a cutter element **24**. The disc **19** is mounted at its periphery between a disc retainer **21** and the end face **22** of the body **10**. The disc retainer **21** is recessed at its center at **23** to provide clearance for the disc **19** when the disc is in the normal or unoperated position of FIGS. **2** and **3**.

The cutter element **24** is guided for longitudinal movement in the body **10** by guide surfaces **26** and is engagable at one end **27** with the center of the disc **19**. The other end of the cutter element **24** is provided with a sloping end face **28** which extends to an edge **29** extending generally perpendicular to the length of the strip **18**.

The snap disc **19** is formed with a shallow dish shape and has two positions of stability between which it moves with snap action when the disc reaches predetermined temperatures, the value of which depends upon the shape and material of the disc. Prior to the operation of the device, the disc **19** is dished away from the conductor strip **18** as illustrated in FIGS. **2** and **3**. This position is referred to herein as the normal or unoperated position of the disc.

When the disc reaches the operating temperature of the device, it moves with snap action from the normal position of FIGS. **2** and **3** to the operated position of FIG. **4** in which the center of the disc is curved toward the conductor strip **18**. The cutter element **24** is sized so that when the disc is in the normal position the edge **29** is spaced slightly from the conductor strip **18** and so that no force of any significance is applied to the conductor strip **18**. The cutter element **24** is preferably molded of a non-conducting material such as phenolic resin and is sufficiently light in weight so that it will not damage the conductor strip **18** so long as the disc remains in its normal position even if the device is mounted in an inverted position so that the edge **29** lays against the conductor strip.

The operation of the snap disc **19** to the operated position, however, causes the edge **29** to engage the conductor strip **18** and exert sufficient lateral force on the conductor strip to cause it to rupture as illustrated in FIG. **4**. The various elements are proportioned so that the cutting edge **29** engages the side of the strip **18** opposite the terminals substantially adjacent to the ends of the teeth **17** on one of the terminal elements. In the illustrated embodiment, such engagement is substantially adjacent to the ends of the teeth on the terminal **11**.

The teeth **17** are preferably formed by a shearing operation which leaves a burr or sharp edge (not illustrated) along the edges of the teeth adjacent to the conductor strip **18**. Such sharp edges facilitate the rupture of the conductor strip when the device operates. Since the edge engages the flat side of the conductor strip **18** substantially adjacent to the ends of the teeth **17** on the terminal element **11**, the strip is pressed laterally against the points of such teeth which produce high localized stress and perform the initial penetration. Continued movement of the cutter element **24** causes the

strip material to shear back along the teeth from the points until the strip is completely cut or ruptured. The various elements are proportioned so that as the disc moves to the operated position of FIG. **4**, the sloping surface **28** bends the end of the strip remaining attached to the terminal **12** away from the terminal **11** to insure that the electrical connection is completely broken.

Preferably, the disc **19** is formed so that it will not snap back to its normal position under any normal environmental temperature encountered. With this structure, the disc remains in the operated position and holds the cutter in between the two cut ends of the strip. However, it is also preferable to form the conductor strip of a material which is sufficiently ductile so that it permanently deforms or bends during operation and remains in the bent or separated position even if the disc snaps back to its normal position allowing the cutter to return to its unoperated position.

The strip **18** may be formed of copper. However, where substantial currents are required, conductor strips are preferably formed of silver. The width of the strip and the thickness is sized so that the currents encountered by the device will not cause any appreciable heating due to current flow. Consequently, the device is operated by the temperature sensed by the disc **19** and is not sensitive to current flow to any appreciable extent.

In the illustrated embodiment, the cutter element **24** is symmetrical about its longitudinal center excepting at the cutter end and provides a central section which is generally cylindrical and opposed axially extending projections **31** which are guided by mating surfaces **32** formed in the body **10** to insure that the edge **29** extends perpendicular to the length of the conductor **18**. The two terminals **11** and **12** are symmetrical with respect to the center axis of the device so the cutter element **24** can be installed in either of two opposite positions.

For example, in the illustrated position, the cutting edge **29** is substantially adjacent to the ends of the teeth on the terminal **11**. However, the cutter element can also be installed in a position 180° of rotation from the illustrated position. In such an event, the cutter edge is located adjacent to the ends of the teeth **17** on the terminal element **12**. With this structure, it is merely necessary to place the cutter element in the body in either of the two positions, and it is not necessary to insure that it is oriented in one position or the other. This simplifies assembly and reduces cost.

Preferably, a transparent insulating disc **33** formed of high temperature plastic such as a high temperature Mylar or the like is inserted and retained in the body above the center portion of the terminals. Since such disc is transparent, the condition of the device can be viewed even though the disc provides some protection for the operation portion of the device. In instances where is is necessary to break two lines of a circuit, a similar device is provided with two separate pairs of terminals and a separate connector strip to connect each pair. In such devices, a single disc operates a single cutter having a cutting edge sufficiently long to engage and rupture both strips.

Because the snap disc provides very rapid operation and great reliability, the device can safely be used to protect circuits in which over-temperature can create a hazardous or damaging condition. Since the number of elements required to manufacture the device is small, and the elements are capable of being manufactured by high production, low cost manufacturing procedures and since the assembly of the device is economical, a low cost, reliable thermal-sensitive fuse device is provided.

Although a preferred embodiment of this invention is illustrated, it is to be understood that various modifications and rearrangement of parts may be resorted to without departing from the scope of the invention disclosed and claimed herein.

What is claimed is:

1. A thermostat fuse comprising a body, a pair of terminals on said body, a frangible conductor electrically connecting said terminals, a bimetallic snap disc mounted at its periphery in said body and providing a central portion movable with snap action from a first position to a second position when the environmental temperature reaches a predetermined temperature, and an operator member supported in said body movable by said central portion to rupture said conductor and break the connection between said terminals when said central portion moves from said first position to said second position.

2. A fuse as set forth in claim **1** wherein said operator member formed with an end shaped to facilitate the rupture of said conductor, said operator member being operatively connected for movement by said snap disc.

3. A fuse as set forth in claim **2** wherein said operator member is an elongated member formed of a non-conductive material with said one end formed with a relatively sharp cutter and the other end engagable with the center of said disc.

4. A fuse as set forth in claim **3** wherein said conductor is a thin sheet of metal and at least one terminal includes sharp projections engagable with said metal on the side opposite thereof from said operator member.

5. A fuse as set forth in claim **4** wherein said operator member and body are provided with interengaging guide surfaces operable to maintain a predetermined orientation of said member.

6. A fuse as set forth in claim **1** wherein said snap disc remains in said second position when its temperature returns to normal environmental temperatures.

7. A fuse as set in claim **6** wherein said conductor is formed of a ductile material, and said operator member non-resiliently bends the ruptured ends of said conductor apart when they move to said operated position.

8. A fuse as set forth in claim **1** wherein said conductor is formed of a ductile material, and said operator member non-resiliently bends the ruptured ends of said conductor apart when they move to said operated position.

9. A fuse as set forth in claim **1** wherein said conductor is a thin strip of metal, and support means are provided on the side of said conductor opposite said operator member, said support means providing localized high stress in said conductor when said operator member moves to said operated position.

10. A fuse as set forth in claim **9** wherein said support means includes a plurality of sawtoothed shaped teeth providing points which produce localized high stress when said operator member operates.

11. A fuse as set forth in claim 10 wherein said operator member engages the side of said conductor opposite said support means along a narrow line substantially adjacent to said points.

12. A fuse as set forth in claim 11 wherein similar support means are provided at two locations spaced along said conductor, and said narrow line is substantially adjacent to one support means and spaced from the other support means.

13. A fuse as set forth in claim 12 wherein said operator member is an elongated cutter engagable with said conductor along said narrow line, said cutter and body being shaped so that said cutter is insertable in said body in either of two positions.

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