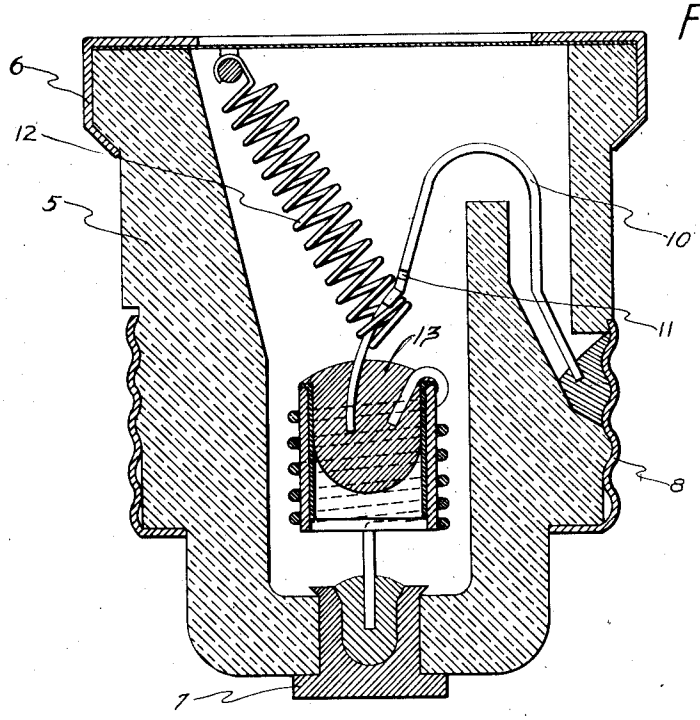
Sept. 15, 1942. H. T. BUSSMANN 2,295,828

PROTECTOR FOR ELECTRIC CIRCUITS

Filed June 13, 1938

Fig. 1



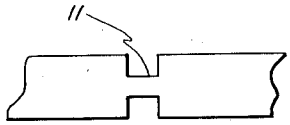
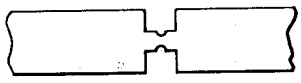




Fig. 2

Fig. 3



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Patented Sept. 15, 1942 2,295,828

# UNITED STATES PATENT OFFICE

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## PROTECTOR FOR ELECTRIC CIRCUITS

Henry T. Bussmann, St. Louis, Mo.

Application June 13, 1938, Serial No. 213,326

2 Claims. (Cl. 200—123)

My invention relates to protective devices for electric circuits designed to open the circuit on excess currents, and particularly relates to 10, 15, 20 and 25 ampere 125 volt devices the most general use of which is to protect ordinary branch circuits.

Such branch circuit protectors must, of course, operate successfully on ordinary overloads and on heavy short circuits. They must protect, however, against another condition which is not usual with other sizes of protective devices, in that the ordinary branch circuits referred to usually have connected thereto flexible cords to operate portable electric lamps and other portable devices of various kinds.

The movement of such portable devices and of the cords attached thereto often results in fraying of the outer braids and rupture of the insulation. As a consequence the bare conductors may be brought in contact with each other, that is the cords very often short circuit on themselves.

Such short circuits will vary in degree tremendously, they may be caused by anything from a tight twisting together of all the strands of both conductors to a light touching of a single strand of one conductor with a single strand of the other conductor.

Obviously there is a vast difference between these two extremes. In the first case referred to the masses of metal are so great and the contact between them is so good that the current will be carried long enough to permit almost any kind of protective device of 10 to 25 ampere capacity to open the circuit before the short can be burned out. This prevents any flash or molten metal being produced where the conductors are shorted. If all short circuits in flexible cords were of this kind there would be little need for my invention.

In the latter case, the flash and amount of molten metal are so small that no harm can result. Ordinary fuses, even of the 10 ampere size, will not open such a short circuit, and there is no reason why they should. The resistance of the short will be so high that the current will be small, and the amount of metal to be fused to open the circuit will be so small that it is entirely safe to permit such shorts to burn themselves out. If all short circuits in flexible cords were of this kind there would be no need for my invention.

Most of the short circuits that occur on flexible cords, however, are between the two extremes above mentioned. It is generaly not safe to let the short burn itself out and the purpose of my invention is to provide a protector that

1. Has sufficient time lag to hold the starting currents of motors connected to such circuits, thereby preventing the useless blowing of fuses when such motors are started, and at the same time,
2. Will protect flexible cords, not only against heavy short circuits referred to, but also against any short circuit which might cause damage if allowed to burn itself out.

The ordinary fuse protects flexible cords against heavy and such medium short circuits reasonably well; but its very short time lag on light overloads is a serious drawback. Many overloads, such as the starting current of alternating current motors, are of such magnitude and duration as to be entirely harmless. Ordinary fuses will very often open the circuit on such overloads. Obviously, such blowing of fuses is useless and not only serves no purpose but causes needless annoyance and expense.

Protectors described in other applications have a thermally-controlled mechanically-operable circuit interrupter and a fuse link combined in a unitary structure so as to provide a device that has a long time lag at low overloads, and blows quickly at higher overloads. The fuse link in such protectors has a higher current carrying capacity than an ordinary fuse of the same rating as the protector and, therefore, will not open as quickly on medium short circuits on flexible cords as would an ordinary fuse having the current rating of the protector.

The purpose of my invention is to produce such protectors which, while retaining all the long time lag characteristics at low overloads, will give on medium short circuits on flexible cords results comparable to, or better than, those obtained on ordnary fuses of the same rating as the protector.

I accomplish this purpose by the design of the fuse link, or, as it may more properly be called, the short-circuiting strip, since it does not perform all the usual functions of a fuse link in forming a part of the protector.

My invention consists of providing protectors with a short-circuiting strip having a properly designed portion of a cross-sectional area substantially less than that of the main body of the strip. I prefer, for mechanical reasons, to provide the reduced cross-section by making a notch in one or both sides of the strip rather than by cutting a slot or hole within the strip. I also prefer to make these notches of such shape as to provide a weak spot the cross-sectional area of which is maintained for a short length at, or near, the minimum value thereof.

The cross-section of a weak spot in a link of a given rating may be such that if the link were of that cross-sectional area throughout its whole length it would not carry its rating. This is because heat is conducted from the weak spot to the other portions of the link. The other portions are, accordingly, made of relatively large cross-sectional area to bring about this effect.

At low currents, then, the greater amount of heat generated in the high resistance weak spot can be conducted away fast enough to very substantially affect the current carrying capacity of the weak spot. On currents sufficiently great to heat the weak spot to fusing temperature in so short a time that conduction therefrom can be but small, the blowing time of the weak spot will be but little affected by conduction of heat therefrom. Accordingly in order to get a short-circuiting strip having a quick blowing time on relatively high overloads, such as the cord shorts mentioned, I use a relatively high resistance weak spot and restrict the conduction of heat from the central portion thereof.

As my invention relates to protectors in which short-circuiting strips are used in combination with mechanically-operable thermal interrupters to form unitary devices the characteristics desired in the strips are different from those desired in links used in ordinary fuses. In ordinary fuses the link is the sole means for breaking the circuit and therefore must operate in a desirable manner at all loads greater than the maximum carrying capacity of the link. In my protector, on the other hand, the short-circuiting strip can never blow at current values near the maximum carrying capacity of the strip as the mechanically-operable interrupter will break the circuit on such currents before the link can fuse. Thus when the link fuses it is always at currents great enough to cause blowing at the weak spot and in relatively short times.

Accordingly the characteristics of the link which govern its blowing times at low and moderate overloads of its own rating, which are of great importance in the design of a link for an ordinary fuse, are of little importance in the design of a short-circuiting strip to be used in a protector of the type to which my invention relates. For example it is desirable that links to be used in ordinary fuses have considerable time lag at low overloads. In a protector of the type to which my invention relates the short-circuiting strip is not opened at low overloads therefore its time lag at such overloads is not of importance. The characteristics of the strips which govern its blowing at relatively high overloads of its rating, such overloads as the cord shorts referred to, are those of greatest importance. The strip desired for use in protectors of this type is one which on such overloads, will blow quickly and open the circuit before the short can burn itself out.

I have found that for protectors of this type a strip with a V-notch does not give the fastest blowing time on cord shorts and that much better results than with a V-notch can be obtained by so shaping the notch that the cross-sectional area of the reduced portion of the strip is maintained at, or near, the minimum value thereof for a substantial length. By thus restricting the heat conducting path from the center of the weak spot the conduction is momentarily retarded and a quicker blow results.

When a strip fuses the circuit is not instantaneously opened if the voltage and capacity of the circuit are moderately great. The current will be carried by an arc across the break until this arc becomes so long its increased resistance prevents its continuance, accordingly in branch circuits such as described the final opening of the circuit does not take place until the arc formed in the blown strip is extinguished. By making my weak spot such that the cross-sectional area is maintained at or near the minimum value thereof for a substantial distance the amount of metal volatilized by the arc is less than would be the case with a V-notch for the same length of arc. This means a greater resistance in the arc and its earlier extinguishment.

Accordingly by my invention I not only decrease the blowing time of the short-circuiting strip but also decrease the arcing time thereof and so further provide for quicker opening of the circuit to be protected.

While it might be possible to make a V-notch strip having so high a resistance at the weak spot as to cause it to fuse as quickly as a strip made in accordance with my invention, the notches would have to be cut so deeply into the sides of the strip that the strip would be so weak as to cause manufacturing difficulties and premature failures. And, even if it were possible to make such a strip, and it did fuse as quickly, the final opening of the circuit would not be as quick because the greater amount of metal volatilized by the arc formed when the strip fuses would prolong the arc for a longer time than would a short-circuiting strip embodying my invention.

In the drawing—

Figure 1 shows a protector embodying my invention, a part of the enclosure being cut away.

Fig. 2 shows an enlarged view of the weak spot used in the protector shown in Fig. 1.

Fig. 3 is an enlarged view of another form of weak spot embodying my invention.

In Fig. 1 is a protector having a body member 5 of insulating material, closure member 6 and contact terminals 7 and 8. Mounted in the body are a thermally-controlled mechanically-operable circuit interrupter and a short-circuiting strip 10 having a portion of reduced cross-sectional area 11 of a preferred form of my invention. The strip and interrupter are connected in series with each other and with the contact terminals 7 and 8. A spring 12 operates the interrupter by withdrawing an end of the strip from connecting position when the holding means 13, which normally maintains this connection, has been heated to a predetermined degree. On overloads up to a certain value the circuit is opened in the interrupter in this manner. On overloads above this value the circuit is opened by fusion of the short-circuiting strip in the portion of reduced cross-sectional area 11.

Fig. 2 is an enlarged view of the preferred form of weak spot 11 used in the protector of Fig. 1. It will be noted that the portion of reduced cross-section is of substantial length relative to its width in order to increase its resistance and to provide on each side of the point where fusion starts a path of limited area for the conduction of heat away from this point.

In Fig. 3 is shown an enlarged view of another form of weak spot embodying my invention. In this modification the portion of reduced cross-sectional area has a portion on each side of its fusing point of somewhat greater cross-section than the minimum cross-section of the fusing point. In this form, as in the previous form, however, a substantial length of relatively small

cross-section increases the resistance of the weak spot and restricts the conduction of heat from the blowing point.

Restricting the conduction of heat from the blowing point of the weak spot is of importance on mild short circuits. On heavy short circuits the blowing time is so short that the effect on the blowing time of conduction of heat from the blowing point becomes negligible.

By forming the strip with a portion of reduced cross-sectional area including a fusing portion and heat-conduction restricting portions adjacent thereto as embodied in my invention I provide a method of obtaining quick blows on overloads above a certain magnitude with consequent improvement in the protection afforded. By varying the dimensions of the portion of reduced cross-sectional area I provide a method of controlling the blowing times, greater length and smaller cross-sectional area of the portion of reduced cross-section resulting in greater amount of heat being generated in the fusing portion and less heat conducted therefrom with consequent shorter blowing time.

While I have shown preferred forms of short circuiting strips embodying my invention I do not wish to be restricted to the exact forms shown as it is obvious that modifications may be made within the scope of my invention.

What I claim is:

1. A unitary protector for electric circuits comprising a thermal interrupter and a short-circuiting strip that are in series relation and are adapted to give dual protection to the said electric circuits, said thermal interrupter being normally maintained in closed circuit position by heat softenable material that is arranged to be heated by current passing through the protector, said thermal interrupter having a portion thereof that is biased toward open circuit position and is adapted to be moved into open circuit position when the said heat softenable material reaches its softening temperature, said short-circuiting strip having a portion thereof intermediate its length that has a reduced cross-sectional area, said portion having a substantially uniform cross-section for a total length at least as great as the width of the said portion, whereby the longitudinal center of the said portion is relatively thermally remote from the portions of the said strip having larger cross-sectional area and can be fused quickly since the heat generated therein will not be conducted readily to the said larger portions, said strip being so dimensioned that it will fuse only when the protector is subjected to relatively large overloads, said thermal interrupter and said short-circuiting strip being arranged so that when the circuit is opened on relatively small overloads by movement of the said biased portion of the thermal interrupter to open circuit position it is opened only after a substantial time lag and being arranged so that when the circuit is opened by fusing of the longitudinal center of the reduced portion of the short-circuiting strip on relatively large overloads it will be opened quickly.

2. A unitary protector for electric circuits comprising a thermal interrupter and a short-circuiting strip that are in series relation and are adapted to give dual protection to the said electric circuits, said thermal interrupter being normally maintained in closed circuit position by heat softenable material that is arranged to be heated by current passing through the protector, said thermal interrupter having a portion thereof that is biased toward open circuit position and is adapted to be moved into open circuit position when the said heat softenable material reaches its softening temperature, said short-circuiting strip having a portion thereof intermediate its length that has a reduced cross-sectional area, said portion having a length at least as great as the minimum width of said portion throughout which length the cross-sectional area is maintained within a value closer to the minimum cross-sectional area of said portion than to the cross-sectional area of the main body of the short-circuiting strip, whereby the longitudinal center of the said portion is relatively thermally remote from the larger main body of the said strip and can be fused quickly since the heat generated therein will not be conducted readily to the said main body, said strip being so dimensioned that it will fuse only when the protector is subjected to relatively large overloads, said thermal interrupter and said short-circuit strip being arranged so that when the circuit is opened on relatively small overloads by movement of the said biased portion of the thermal interrupter to open circuit position it is opened only after a substantial time lag, and being arranged so that when the circuit is opened by fusing of the longitudinal center of the reduced portion of the short-circuiting strip on relatively large overloads it will be opened quickly.

HENRY T. BUSSMANN.