

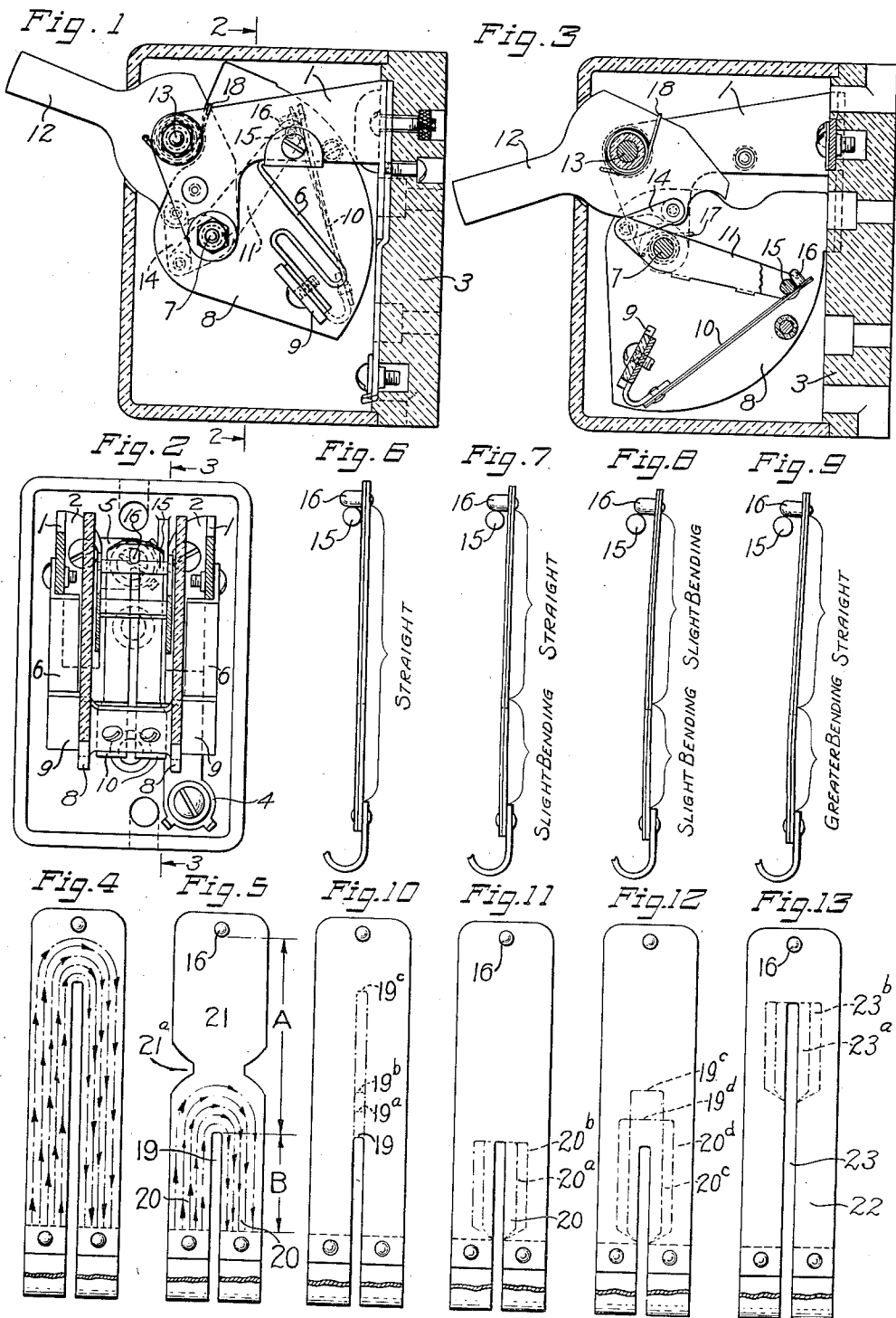
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CURRENT RESPONSIVE ELEMENT AND METHOD OF MANUFACTURE THEREFOR

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CURRENT RESPONSIVE ELEMENT AND
METHOD OF MANUFACTURE THERE-
FOR

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4 Claims. (Cl. 200—113)

The invention relates to bi-metallic strips adapted for use as the current responsive elements of automatic circuit breakers, and has particular advantages when incorporated in bifurcated or U-shaped strips. The invention is applicable to various types of circuit breakers in which use is made of bi-metallic strips of the character described, but the invention has particular advantages when embodied in a circuit breaker wherein the bi-metallic strip is bodily movable, as illustrated for instance in my prior Patents No. 1,812,842, No. 1,811,970 and No. 1,812,848 all dated June 30, 1931.

One of the objects of the invention is to provide a bi-metallic thermostatic strip of such character as to provide a predetermined delay or time lag in the automatic operation of the circuit breaker when the current through the circuit breaker is not greatly in excess of the predetermined capacity without, however, interfering with the practically instantaneous operation of the circuit breaker under short circuit conditions. This result is accomplished by properly proportioning the different parts of the strip as will be herein described in detail.

Another object of the invention is to provide a novel method of manufacture which makes it possible for the manufacturer of circuit breakers to provide circuit breakers of various current carrying capacities and with various time lag characteristics by merely varying certain dimensions of the unitary strips without otherwise essentially changing them.

In the accompanying drawing I have shown one form of circuit breaker embodying the invention, and I have illustrated diagrammatically the construction and manner of operation of the improved thermal strip incorporating my invention. It will be understood that the drawing is intended for illustrative purposes only and that the construction shown can be widely varied, particularly as concerns the circuit breaker mechanism, without departing from the spirit of the invention, as set forth in the claims forming a part of this specification.

Of the drawing:

Fig. 1 is a side view of a circuit breaker embodying the invention, the base and enclosure for the circuit breaker being shown in section.

Fig. 2 is a vertical sectional view taken along the line 2—2 of Fig. 1, the enclosing cover being omitted.

Fig. 3 is a vertical sectional view taken along the line 3—3 of Fig. 2.

Fig. 4 is a detail view of a typical bi-metallic strip of the prior art.

Fig. 5 is a detail view of a bi-metallic strip incorporating the invention.

Figs. 6 to 9 are diagrammatic views showing the action of a thermal strip embodying the invention.

Figs. 10 to 13 are diagrammatic views illustrating the method of manufacture constituting a part of the invention.

In order that the invention may be clearly understood I have shown in Figs. 1, 2 and 3 the essential parts of a circuit breaker mechanism, having selected for this purpose that shown in my aforesaid Patent No. 1,812,848. It will be understood, however, that the invention in its broader aspects is not limited to a circuit breaker of the type having a bodily movable thermal strip, and is not in any event limited to the particular details of mechanism shown in Figs. 1 to 3.

The mechanism as illustrated in the said Figs. 1 to 3 comprises two parallel spaced side plates 1, 1 provided with flanges 2, 2 by means of which they are attached to a rear insulating base 3. These plates 1, 1 constitute parts of the conducting circuit and they are connected respectively with wire terminals 4 and 5. Carried by and electrically connected with the two plates 1, 1 are two similar stationary contacts 6, 6.

Pivotally mounted on the plates 1, 1 at 7 are two arcuate plates 8, 8 of insulating material which, together with elements carried thereby, will be designated as contact members. The said plates 8, 8 are mechanically connected for movement in unison and they carry at their respective outer faces movable contacts 9, 9 which are adapted to electrically engage the stationary contacts 6, 6 as shown in Fig. 1. The said contacts 9, 9 extend through the plates 8, 8 and the portions thereof between the said plates are connected respectively with the legs of a U-shaped bi-metallic strip 10 which thus serves as the electrical connection between the two movable contacts.

Also pivotally movable about the axis at 7 is an actuating member 11 which is located between the plates 8, 8. For moving the actuating member 11 there is provided a handle member 12 pivotally mounted between the plates 1, 1 for movement about an axis at 13. The handle member 12 is connected with the actuating member 11 by means of a link 14. The actuating member 11 includes a transverse bar or pin 15, and the bi-metallic strip 10 carries a rounded stud 16 which normally engages the pin 15. It will

be observed that the bi-metallic strip 10 with its stud 16 thus serves as a mechanical latch to connect the movable contact member with the actuating member. With the latch fully engaged as shown in Figs. 1 to 3 the actuating member 11 can be moved by means of the handle member 12 and the link 14, and the actuator serves in turn by means of the bi-metallic strip 10 and the stud 16 to effect corresponding movements of the contact member to close or open the circuit.

There is provided a spring 17, shown in Fig. 3, for biasing the contact member toward its open-circuit position, and there is also provided a spring 18 for biasing the handle member 12 toward its open-circuit position. With the parts in the position shown in Fig. 1 the relationship of the link 14 to the handle member 12 is such that the parts are locked against movement under the influence of the said springs 17 and 18. If, however, excess current passes through the circuit breaker the bi-metallic strip 10 is deflected outward as the result of the heating action therein so that the stud 16 disengages the pin 15. This permits the contact member to instantly move to open-circuit position under the influence of the spring 17. The disengagement of the strip 10 from the actuating member 11 removes the pressure which was theretofore exerted upon the actuator, with the result that the link 14 no longer holds the handle member 12 in closed-circuit position and the handle member thereupon moves to open-circuit position under the influence of the spring 18. The handle member carries the actuating member with it, thus causing reengagement of the pin 15 of the actuating member with the stud 16 on the thermal strip as soon as the latter has sufficiently cooled. The operative relationship is thus restored, and by movement of the handle the circuit can be closed.

According to the usual prior practice the central longitudinal slot in the thermostatic strip has been relatively long, usually a length as great as permitted by the length of the strip. In some instances, the slot has been somewhat shorter, but the effective length of the inner slotted portion has nevertheless been much greater than the effective length of the outer unslotted portion. A portion of the unslotted portion of the strip is in any case required for the transverse passage of current between the legs, and therefore as the result of the prior relationship between the lengths of the slotted and unslotted portions, current was caused to flow throughout substantially the entire length of the strip, with the result that instantaneous heating was effected throughout substantially the entire length of the strip upon the passage of excess current. This will be evident from an inspection of Fig. 4 which shows a typical prior art strip.

The rapid heating of the strip throughout its entire length is desirable when it is desired for the circuit breaker to act very quickly in the event of even a moderate excess current. For many classes of service, however, particularly for the starting of small motors, the circuit breaker should not open instantly upon the passage of a moderate excess current. If the excess is moderate, with the current promptly returning to normal, the circuit breaker should not open at all, but if the moderate excess is continued during a predetermined short interval of time the circuit breaker should then open. The before-described time lag characteristics under moderate excess current conditions should not in any

way interfere with the practically instantaneous opening of the circuit breaker under extreme excess current or short circuit conditions.

The foregoing advantageous results are obtained by the modified bi-metallic strip construction which is shown in detail in Fig. 5 and which will now be described. The longitudinal slot 19, which divides the inner end portion of the strip 10 into current carrying legs 20, 20, is very much shorter than has heretofore been the usual practice, with the result that the effective length A of the unslotted broad outer body portion 21 is actually somewhat greater than the effective length B of the said legs 20, 20. The said portion 21 may be much longer than the said legs, as for instance one and one-half times as long, or even twice as long as shown in Fig. 5. With a bi-metallic strip proportioned as shown in Fig. 5 it will be observed that the direct heating action due to the passage of current in the unslotted end portion of the strip is substantially reduced, such heating action of the current taking place chiefly in the inner section immediately adjacent the slot. Notches such as 21^a are cut in the sides of the broad body portion in order to more completely confine the direct heating action of the current to the inner section of the said portion and in order to restrict the rate of heat transfer from the inner section to the outer section.

The diagrammatic Fig. 6 shows a normally straight thermal strip through which no current is passing or in which the current does not in any event exceed the predetermined capacity for which the circuit breaker is rated. The strip remains straight or substantially straight throughout its entire length.

Fig. 7 shows the condition which arises upon the passage of a moderate excess current through the strip. As already pointed out the direct heating action of the current is substantially limited to the inner portion of the strip adjacent the slot, and particularly to the legs 20, 20, and the result is that the said lower portion becomes heated and slightly deflected or bent as indicated. The outer part of the unslotted portion, however, is not initially affected as it carries very little current and remains substantially straight. With only a moderate excess current the curvature at the inner portion of the strip does not cause sufficient movement of the stud 16 to disengage it from the pin 15 and the circuit breaker remains closed, notwithstanding the moderate excess current flowing therethrough. However, if this excess current is continued the outer unslotted portion of the strip gradually becomes heated by reason of heat transmitted from the inner portion which is heated by the current as already stated. After a short time interval the outer unslotted portion becomes heated and is correspondingly slightly deflected as indicated in Fig. 8, with the result that the stud 16 is then withdrawn far enough to become disengaged from the pin 15. This permits the circuit breaker to open as already described. It will be seen that by concentrating the initial heating of the strip at the lower end thereof I am enabled to effect a delay or time lag in the opening of the circuit breaker which can be definitely determined within any reasonable limits by properly proportioning the strip.

Notwithstanding the delayed action which is obtained as the result of only a moderately excess current, a thermal strip embodying my invention is practically instantaneously effective in the case of an extreme excess current or a short circuit. As shown in Fig. 9 the short circuit will act in-

stantly to heat the inner portion of the strip causing a much greater deflecting thereof than was the case with the moderate excess current as indicated in Fig. 7. This greater deflecting causes the instant release of the stud 16 from the pin 15 without waiting for the outer unslotted portion of the strip to become deflected as the result of transmitted heat.

In connection with Figs. 5 to 9 I have explained the principle which I utilize in controlling an operating characteristic of the circuit breaker, as for instance in effecting delayed action of the circuit breaker. The extent of the delay or time lag is almost wholly dependent on the length of the slot in the strip. With a very long slot, such as was common in the prior art and such as is shown in Fig. 4, there was only a relatively small time lag. With a rather short slot such as is shown in Fig. 5, the time lag may be quite considerable. Within certain reasonable limits any desired extent of time lag can be obtained by varying the length of the slot as indicated in Fig. 10. If the slot initially has the length 19 as shown by full lines, the time lag will be large. By increasing the length of the slot, as indicated at 19^a or 19^b, the amount of time lag can be reduced as desired. If the length of the slot be greatly increased, as shown at 19^c, the time lag may be greatly reduced. By making use of this principle it is possible for the manufacturer to provide a basic size and style of bi-metallic strips with uniform major dimensions, and to then obtain any desired reasonable time lag characteristics for different circuit breakers merely by varying the lengths of the slots in the strips.

The current carrying capacities of the strips may be readily changed by varying the widths of the current carrying legs of the strips. As illustrated in Fig. 11 the legs may have the full width 20 or they may have reduced widths as indicated at 20^a or 20^b. The heating action will be largely concentrated in the narrower portions 20^a or 20^b. Changing the widths of the current carrying legs may change the heating effect and may, therefore, change the rate of transmission of heat to the unslotted portion, thus changing the time lag characteristic of the strip. Compensation for this may be made by varying the length of the slot simultaneously with the variation of the widths of the legs, as illustrated in Fig. 12. If the slot is increased in width to provide the narrower legs 20^c or 20^d the slot may be also increased in length as indicated at 19^c or 19^d in order to provide the same, or, if desired, different time lag characteristics. It will be observed that by varying the widths of the legs and at the same time varying the lengths of the slots any desired capacities and time lag characteristics can be obtained without changing the major dimensions of the strips.

In Fig. 13 I have shown another plan for obtaining at least a part of the advantages that have been described. I have shown a strip 22 having a slot 23 which may correspond in length to the slots of the prior art. By changing the width of the slot at the outer portion thereof as indicated at 23^a or 23^b the current carrying capacity can be changed. The heating action is in large meas-

ure concentrated in the narrower portions at 23^a or 23^b as the heating effect is much less in the inner wider portions of the legs. The heat generated in the narrower portions is only slowly transmitted to the wider portions of the strip and an increased time lag results. It will be observed that the strip shown in Fig. 13 and those shown in Fig. 5 and Fig. 11 are similar in that, in each case, there are portions of the legs in which the heating action is largely concentrated, which portions are much shorter than the total effective length of the strip.

It will be observed that the method of manufacture illustrated in Figs. 11 to 13 and already described in detail, involves the use of unitary bi-metallic strips, each of which consists of only a single piece of bi-metallic metal. I entirely avoid the use of any additional current-carrying part either fixedly or movably secured to the strip. The adjustment or calibration to provide different operating characteristics is effected solely by changing the size and shape of the slot in the strip.

What I claim is:

1. For use as the current-responsive element of an automatic circuit breaker, a U-shaped bi-metallic current-carrying strip slotted adjacent its inner or supporting end to provide two parallel short legs of uniform narrow section and relatively high resistance and quickly deflectible as the result of excess current therethrough and comprising adjacent its outer end a long broad unslotted body portion deflectible only to a negligible extent as the result of the said current but nevertheless subject to delayed deflecting by reason of heat transmitted from the current heated legs, the said broad body portion of the strip having therein between the ends thereof two opposite notches to restrict the heating of the said body portion.

2. A system of manufacture for longitudinally slotted unitary current-carrying bi-metallic strips adapted to serve as the current-responsive elements of automatic circuit breakers, which system comprises varying the total lengths of the slots in accordance with a required operating characteristic and while maintaining the external dimension of the strips unchanged.

3. A method of manufacture for longitudinally slotted unitary current-carrying bi-metallic strips adapted to serve as the current-responsive elements of automatic circuit breakers, which method comprises varying the total lengths of the slots in accordance with the required time lag characteristics while maintaining the external dimension of the strips unchanged.

4. A method of manufacture for longitudinally slotted unitary current-carrying bi-metallic strips adapted to serve as the current-responsive elements of automatic circuit breakers, which method comprises varying the widths of the current-carrying portions of the strips at the sides of the slots in accordance with the required current capacities and varying the total lengths of the slots in accordance with the required time lag characteristics.

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