Aug. 24, 1937. H. C. GRAVES, JR 2,090,754

ELECTRIC CIRCUIT INTERRUPTER

Filed Jan. 21, 1936 3 Sheets-Sheet 1

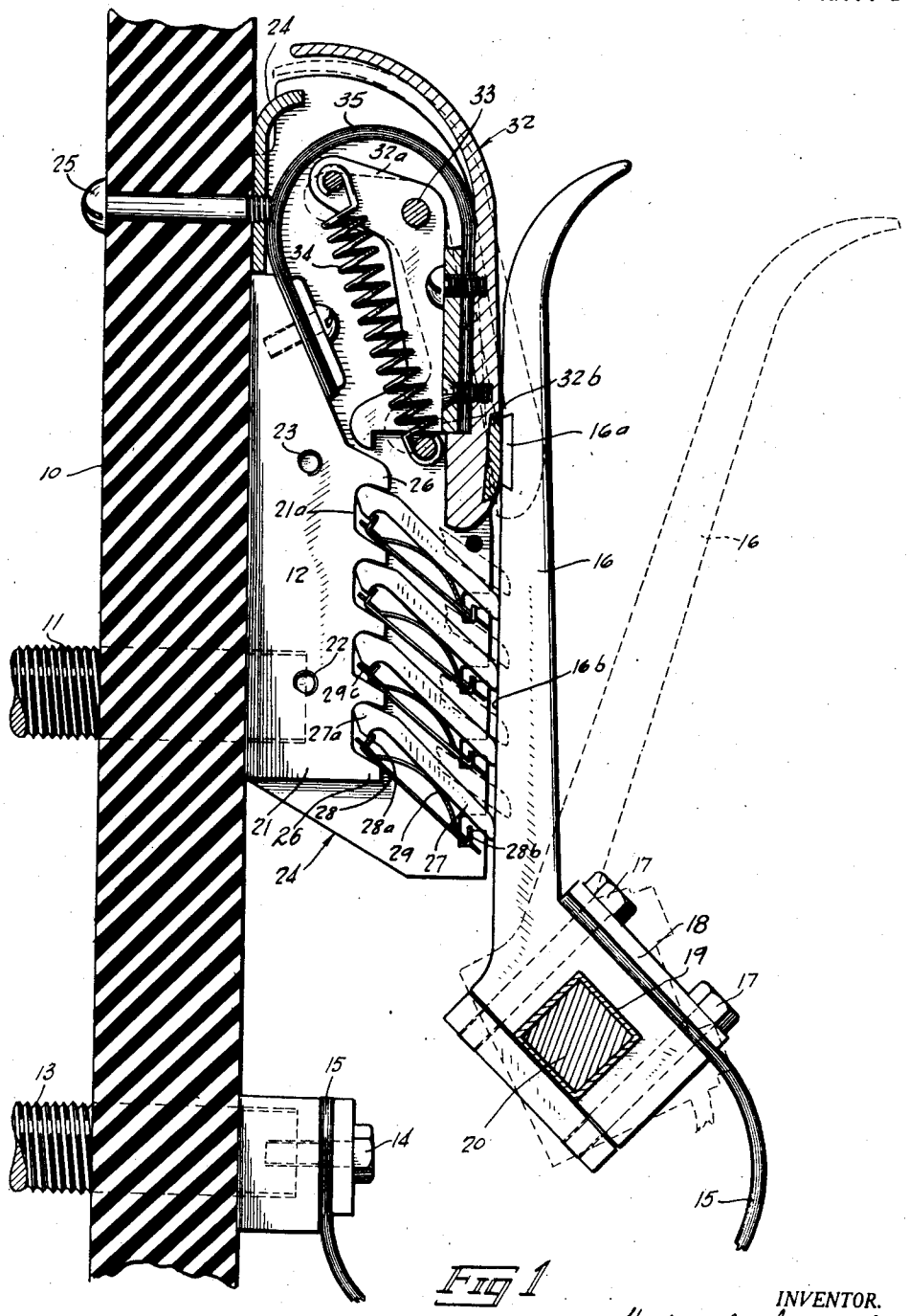


Fig 1

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ELECTRIC CIRCUIT INTERRUPTER

Filed Jan. 21, 1936 3 Sheets-Sheet 2

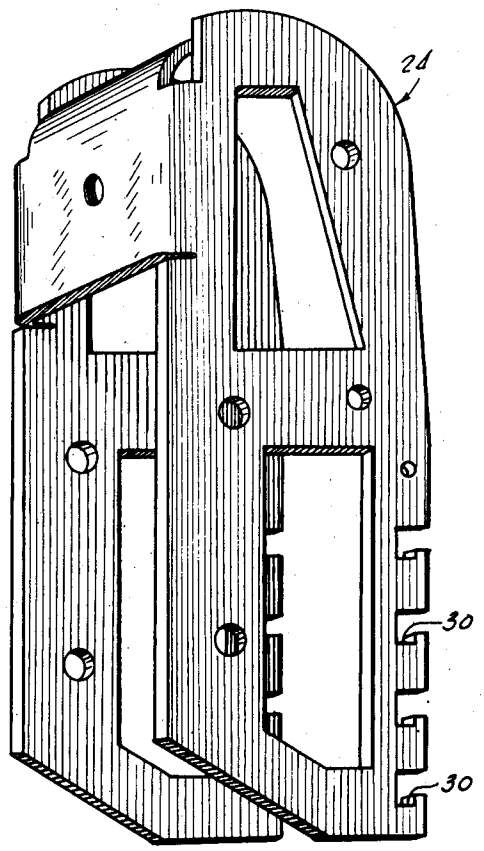


Fig 3

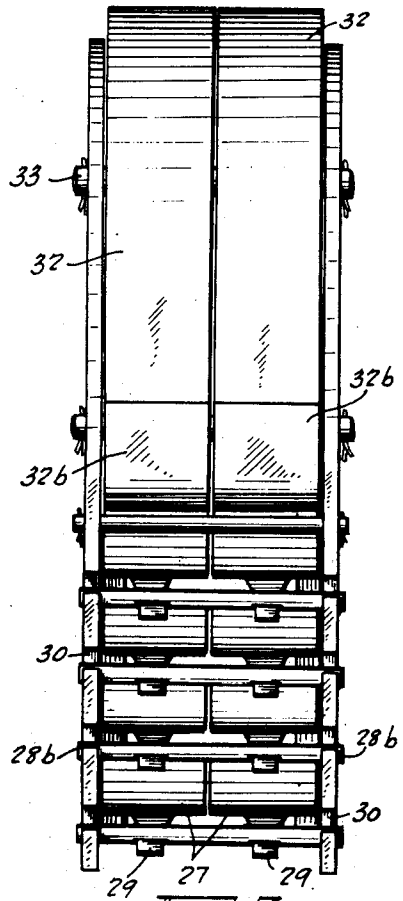


Fig 2

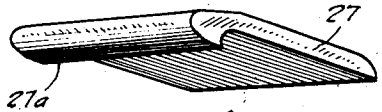


Fig 4

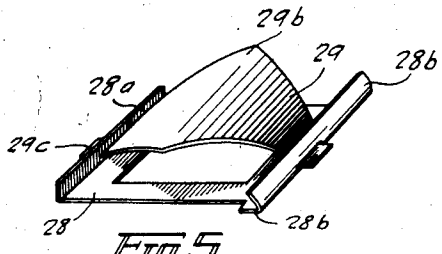


Fig 5

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ELECTRIC CIRCUIT INTERRUPTER

Filed Jan. 21, 1936 3 Sheets-Sheet 3

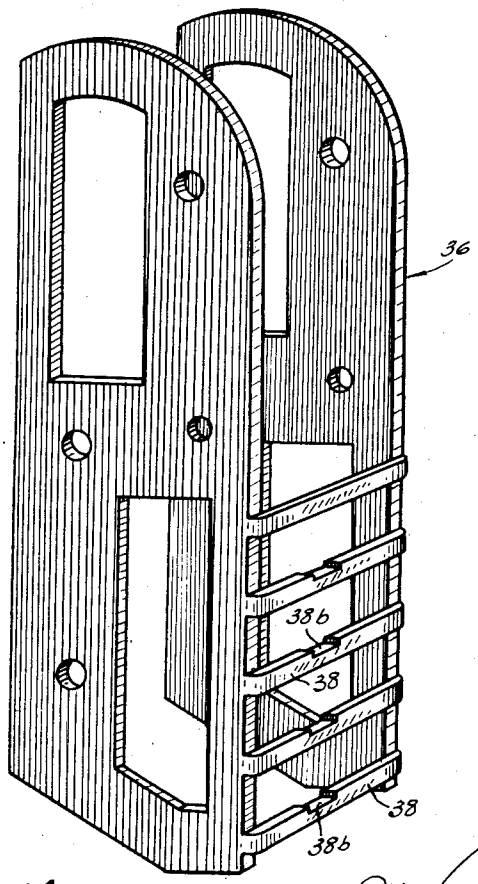


Fig 8

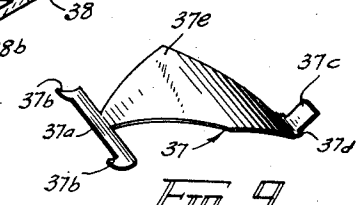


Fig 9

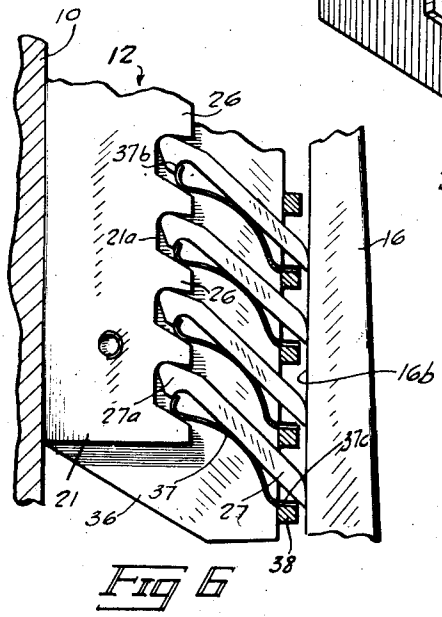


Fig 6

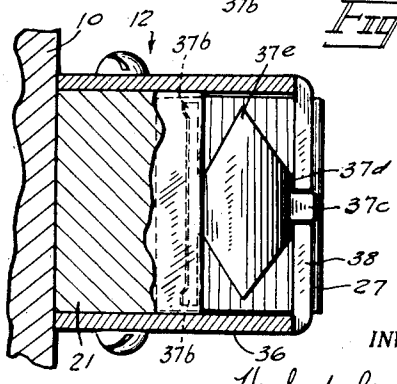


Fig 7

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Patented Aug. 24, 1937

2,090,754

UNITED STATES PATENT OFFICE

2,090,754

ELECTRIC CIRCUIT INTERRUPTER

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Application January 21, 1936, Serial No. 60,017

18 Claims. (Cl. 200—165)

My invention relates to electric circuit interrupters or automatic circuit breakers, more particularly to new and improved separable contacts therefor, and has for an object the provision of simple, rugged and inexpensive contact structures of high current-carrying capacity.

In my Patent 2,028,204, issued January 21, 1936, for Electric circuit interrupters, a circuit breaker and contact structure of which the present application is an improvement is disclosed. While circuit breakers of the type shown in my aforesaid patent have been entirely satisfactory for their intended purposes, something was yet to be desired in simplification of the structure to provide ready removal of the bridging elements as well as to prevent movement of the bridging elements by the magnetic forces produced upon flow of abnormally high currents or currents of short-circuit magnitude.

In carrying out my invention, in one form thereof, I provide a plurality of ridges along the face of one of the contact structures, which ridges cooperate respectively with the ends of a plurality of bridging elements to prevent movement thereof and insure the maintenance of substantial contact pressures between the elements and their associated contact structures. The ridges are also utilized to support corresponding ends of leaf springs interposed between adjacent bridging elements. The opposite ends of the springs are supported as by cross bars extending between the walls of a frame or housing or by separate mounting means having projections cooperating with notches formed in the walls of the associated housing. In either case, the springs and bridging elements are removable from the housing without disturbing other parts of the interrupter.

The leaf springs are, according to a further aspect of my invention, preferably dimensioned so that when compressed upon closure of the circuit interrupter the springs are uniformly loaded throughout their length; that is to say, every portion of each spring is stressed or loaded to the same extent as every other portion. Overstressing of the springs at any one particular point is thereby eliminated although the springs are sufficiently flexible to permit wiping and/or rolling contact engagement between the respective ends of each bridging element and their associated stationary and movable contact structures.

For a more complete understanding of my invention, reference should be had to the accompanying drawings wherein

Figure 1 is a vertical elevation, partly in section, of a circuit interrupter embodying my invention;

Fig. 2 is a front elevation of the stationary contact structure and bridging elements of Fig. 1 with the movable contact blade or structure omitted;

Fig. 3 is a perspective view of the supporting frame of Figs. 1 and 2 with the stationary contact structure and other parts removed;

Fig. 4 is a perspective view of one of the duplicate bridging elements of Figs. 1 and 2;

Fig. 5 is a perspective view of one form of leaf spring and its associated supporting member;

Fig. 6 is a fractional side elevation of a circuit interrupter embodying my invention in modified form;

Fig. 7 is a plan view, partly in section, of Fig. 6 with a bridging element omitted to illustrate the manner in which the leaf springs are supported;

Fig. 8 is a perspective view of the supporting frame of Figs. 6 and 7;

Fig. 9 is a perspective view of one of the leaf springs of Figs. 6 and 7.

Referring to the drawings, I have shown my invention in one form as applied to a circuit interrupter comprising a base or panel member 10 from which is supported a terminal stud or post 11 connected to a stationary contact assembly 12. A second terminal stud or post 13, also supported from the panel 10, has secured to its inner end, as by cap screw 14, one end of a flexible conductor 15, the opposite end of which is connected to a movable contact structure or bridging arm 16 as by cap screws 17 and a clamping plate 18. Preferably insulation, as indicated at 19, is interposed between the arm 16 and an operating member or shaft 20. The movable contact structure or arm 16 is operable between the closed circuit position illustrated by the full lines of Fig. 1 and an open circuit position indicated by the broken lines of Fig. 1 by any suitable mechanism, though preferably of the type disclosed in reissued Patent Number 19,753, Graves and Jensen.

As will be explained more fully hereinafter, one or more bridging arms 16 may be mounted side by side on the operating shaft, a stationary contact assembly 12 supporting a series of bridging elements 27 for cooperation with each of the arms 16. To simplify the description and operation, only one arm 16 and its associated station-

ary contact assembly will be described, it being understood that the operation of additional duplicate parts is the same as that described.

The stationary contact assembly 12 comprises a stationary contact block or member 21 mounted as by screws 22 and 23 between opposite walls of a frame or housing 24 fastened to the panel 10 as by screw 25, the stud 11 being secured in intimate electrical contact with the stationary contact member 21. One face of the member 21 is provided with reentrant angles 21*a* formed by a series of ridges 26 spaced one above the other. Within the angles or recesses 21*a* formed therebetween are disposed the inner ends or edges of the series of duplicate bridging elements 27 each of which is provided with an offset portion forming a hook-shaped end 27*a*. Engaging each end 27*a* is an upturned end or flange 28*a* of a plurality of flat or plane supporting members 28 provided for curved leaf springs 29. Each supporting member 28 adjacent its end 28*a* rests upon the upper portion of an associated ridge 26. The opposite end of each supporting member 28 is provided with lateral projections 28*b*, Fig. 5, arranged to fit within C-shaped slots or recesses 30, Fig. 3, provided in the front of the respective walls of the housing 24. Preferably the C-shaped recesses 30 are staggered with respect to the reentrant angles so that the bridging elements 27, their springs 29 and supporting members 28, extend diagonally between the opposing contact faces of contact member 21 and of the movable bridging arm 16.

In order to relieve the bridging elements, the primary functions of which are to provide low resistance paths between the movable and stationary contact members, from the duty of making and breaking the circuit, which may extend between posts 11 and 12, an auxiliary arcing contact structure is provided and comprises an arcing contact 32 journalled on a pivot pin 33 supported between the side plates of the housing 24. The arcing contact 32 has an associated arm 32*a* to which is secured a biasing spring 34 effective to maintain the lower end of the contact 32 in a position, indicated by broken lines, first to be engaged by the movable arm 16 during circuit-closing operation, the arm 16 also interrupting the circuit at the arcing contact after the current has been transferred from the bridging elements 27 to the arcing contact 32. In order better to withstand the heat of the arc incident to the opening of the circuit, the arcing contact 32 and the associated movable contact or arm 16 are provided, respectively, with arc-resistant inserts or facings 32*b* and 16*a*. A flexible conductor 35 is electrically connected to the stationary contact member or block 21 and to the arcing contact 32 to insure a low resistance current path therebetween.

Assuming the movable contact arm 16 is in the open circuit position, it will be observed the respective leaf springs 29 support their associated bridging elements 27 in elevated positions shown by the broken lines. As the movable contact arm 16 is rotated in a counterclockwise or circuit-closing direction, it first engages the arcing contact 32 to complete an electrical circuit between terminal posts 11 and 13. The arcing contact 32 upon further movement of the arm 16 rotates in a clockwise direction, and a regular contact surface 16*b* of arm 16 is moved into engagement with the corresponding outer and rounded ends of the bridging elements 27. By a regular contact surface, I mean one which does not have reentrant angles or ridges projecting therefrom. Such a regular surface includes plane as well as curved contact surfaces. Continued movement of the arm 16 results in downward movement of the outer ends of elements 27 against the bias of their respective leaf springs 29. During this downward movement a substantial component of the circuit-closing pressure, by reason of a camming action between the rounded end of each element and the angularly disposed contact arm 16, is effective to press the inner rounded ends of the elements against the stationary contact member. Therefore, while the outer ends of the bridging elements slide and wipe and clean the plane contact surface 16*b* to insure good electrical contact therebetween, the inner rounded ends of the bridging elements by virtue of their rolling and sliding engagement with the walls of the respective recesses, wipe and clean the surface of the stationary contact member. The final closed circuit position is shown in Fig. 1, the distance between the respective contact surfaces being uniform at all points.

Although, during the aforesaid closing operation, the bridging elements are capable of self-adjustment and have sufficient independent freedom of movement to take care of misalignment and different degrees of wear as between different elements, it is desirable when the circuit interrupter is in its fully closed position to prevent movement of the elements because of magnetic forces or the like. To this end the ridges 26 form rigid stops for the inner ends or edges of each of the bridging elements and prevent, as viewed in Fig. 1, upward movement thereof. A strong tendency to move the elements 27 upwardly may be created by flow of short-circuit current or currents of high or like value because the magnetic forces developed are applied to each bridging element in a direction to lift its inner end as well as its outer end. In accordance with my invention, however, such magnetic forces as may be produced are effective to increase the contact pressure between each bridging element and its associated overlapping ridge. With respect to the outer ends of the bridging elements, the magnetic forces produced are in a direction tending to lift and hold them against the plane or regular contact surface 16*b* of the contact member or arm 16. The upward tendency of the outer ends of the elements, because of the angular relation between each element and surface 16*b*, is prevented. Stated differently, the magnetic forces tend to move the bridging elements toward the outside of the angles formed between the plane of each member and the face of the movable and stationary contact structures. The respective ridges and surface 16*b*, however, form stops which prevent any movement thereof toward the outside of said angles. The angular relation between each bridging element and the contact surface 16*b* gives rise to a camming action therebetween which actually moves or tends to move the bridging element towards the contact block 21, thereby increasing the bias of each element within its recess or against the ridge. Because of the aforesaid features increased circuit-closing pressures between the respective contact surfaces are produced which have the effect of minimizing the contact resistance and of preventing the occurrence of arcs therebetween.

In addition to the aforesaid structural features of my invention, I have found it advantageous to construct each leaf spring so that the contact

pressure is applied intermediate the ends, one or both ends of each spring being free to slide to permit the necessary lost motion incident to the wiping engagement of the contact surfaces. Referring to Figs. 1 and 5, it will be observed the respective rectangular ends of each arcuate leaf spring **29** are free to slide through openings provided in the oppositely disposed upturned ends or flanges of its associated supporting member **28**. As shown, the supporting member **28**, Fig. 5, is stamped from sheet metal, opposite edges or flanges **28***a* and **28***b* of which are bent at right angles to the body portion thereof. To provide uniform loading of the spring, the cross-sectional area of the intermediate curved portion **29***b* diminishes from its central portion towards opposite ends of the spring in accordance with the increase of lever arm; i. e., the smaller the cross-sectional area the farther from the point where the load is applied. In consequence, each spring, the body portion of which is diamond-shaped, has substantially uniform unit stress for any given deflection; there are no over-stressed portions and the life of each spring is correspondingly lengthened.

Further in accordance with my invention, the bridging elements may be readily removed from the interrupter without disturbing other parts of the circuit interrupter. As will be clear by referring to Figs. 2 and 3, the respective C-shaped slots **30** are wide enough at their open ends to permit removal of the lateral projections **28***b* of the supporting member **28**, the removal being accomplished by lifting the supporting element **29** until its outer end can be moved outwardly through the recesses **30**. The bridging elements and spring assembles are then free for complete removal from the interrupter. To insert new bridging elements, or to return the old ones into position, the aforesaid steps are repeated in the reverse order. The ready accessibility and removability of the bridging elements is of great practical advantage inasmuch as the bridging elements **27** may be readily removed for inspection or renewal without disturbing other parts of the interrupter.

As shown in Fig. 2, two stacks of bridging elements **27** are arranged side by side, for cooperation with a movable contact structure (not shown). For even greater current-carrying capacities, it may be desirable to provide additional duplicate contact structures. The spring supports **28** in each case may be provided with a plurality of openings in their respective flanges for insertion therein of a number of springs **29** corresponding to the number of stacks of bridging elements, or separate supports may be provided for each corresponding spring of each stack.

While the example of the invention disclosed has four bridging elements assembled in vertical relationship, it is obvious that any convenient number may be used.

Referring to Figs. 6 to 9, inclusive, I have shown a modified form of my invention wherein each leaf spring performs the dual functions of retaining the bridging elements in position and of biasing them against their respective contact surfaces under circuit-closing pressure. As illustrated in Fig. 9, each arcuate leaf spring **37** is relatively wide at its center, gradually decreasing in cross-sectional area towards opposite ends thereof as described in connection with Fig. 5. In this case, however, the leaf spring terminates in a wide, laterally extending edge **37***a* which is curved upwardly, pointed projections or nibs **37***b* at opposite ends of said edge extending into engagement with the hook-like ends **27***a* of the respective bridging elements. The wide lateral edge or end **37***a*, in effect formed by arms extending at right angles to the longitudinal axis of the spring, increases the stability of the supporting arrangement and is particularly desirable where the bridging elements are relatively great in width. The outer rectangular end **37***c* of each leaf spring is provided with shoulders **37***d* which engage the inner wall of its associated cross bar **38** to prevent outward movement of the spring. The outer ends **37***c* of the springs rest within notches or recesses **38***b* provided in each cross bar. As shown, each cross bar is formed integrally with the side walls of the housing **36**, though it is to be understood the cross bar may be rigidly secured thereto or to other supporting structure as by fastening screws.

With the interrupter in the open-circuit position, the upwardly extending nibs or projections **37***b* engage their respective elements **27** to hold them in position. Obviously, by raising the outer and lower ends **37***c* of each of the springs until their shoulders **37***d* respectively clear the notches **38***b*, the springs and elements **27** may be removed for inspection or replacement.

The normal curvature of the diamond-shaped body portion **37***c* of each spring is sufficient to retain the outer end of its associated bridging element in an elevated position. As the movable contact arm is moved into engagement with the outer ends of the bridging elements, the sliding and rolling engagement of the contact surfaces under circuit-closing pressure cleans them. Each spring is compressed in the fully-closed circuit position to insure substantial contact pressure. In addition to the forces applied along the diagonally disposed bridging elements, a component of the force developed by each spring is applied through nibs **37***b* to the left-hand end of each bridging element in a direction to increase the contact pressure between each element and the stationary contact member **21**.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim is:

1. In an electrical circuit interrupter, cooperating relatively movable contact structures, one of which is provided with a plurality of contact surfaces disposed respectively within reentrant portions thereof, and the other of which is provided with a regular contact surface, a plurality of rigid bridging elements extending, respectively, diagonally outwardly from within said reentrant portions, and resilient means yielding to permit said elements to tilt slightly, opposite ends of said elements in circuit-closing position of the interrupter engaging respectively said contact surfaces of said structures.

2. In an electrical circuit interrupter, cooperating relatively movable contact structures, one of said structures including a plurality of parallel rigid conducting elements extending diagonally outwardly therefrom, said one structure having a plurality of ridges respectively forming stops for corresponding ends of said elements, the other of said structures having a regular contact surface, a plurality of springs alternately disposed between and each engaging one of said rigid con-

ducting elements between opposite edges thereof, and individual means disposed on corresponding sides of each of said elements for supporting the opposite ends of said respective springs, said springs yielding to permit a slight tilting of said conducting elements, and said elements in the closed-circuit position of the interrupter disposed to complete at said opposite edges a bridging connection between said structures.

3. In an electrical circuit interrupter, a contact member the cross-section of which has reentrant angles, bridging elements individual to, and one end of each disposed within, said angles, biasing means individual to said elements for retaining said elements within said angles and in diagonal outwardly extending positions, a second contact member in circuit-closing position of the interrupter engaging under circuit-closing pressure the ends of said elements remote from said angles, said biasing means yielding to permit said elements to tilt a slight amount and at their opposite ends wipe said contact members under circuit-closing pressure.

4. In an electric circuit interrupter, a contact member provided with a plurality of recesses, a plurality of rigid conducting elements, one end of each of said elements being operatively associated with one of said recesses, individual means for retaining corresponding ends of said elements within said respective recesses, individual leaf springs, the respective ends of which are supported by said individual retaining means for exerting a bias against their associated elements, a second contact member for engaging in circuit-closing position of the interrupter the opposite ends of said elements, said springs, upon application of circuit-closing pressure between said contact members, yielding to permit said elements to rotate a slight amount about their respective ends within said recesses and thereby provide wiping contact engagement between opposite ends of each of said elements and said contact members.

5. In an electrical circuit interrupter, cooperating relatively movable contact structures one of which has a series of recesses disposed between a plurality of ridges, a series of rigid bridging elements extending diagonally between said contact surfaces, one end of each of said elements nesting within one of said recesses, individual resilient means engaging said elements adjacent one end and engaging said elements intermediate the ends, and yielding to permit said elements while substantially parallel to rotate about their respective ends to wipe said structures under circuit-closing pressure.

6. In an electrical circuit interrupter comprising a contact member provided with a plurality of ridges spaced one above the other along one face thereof to form a plurality of recesses therebetween, a plurality of bridging elements, each of the corresponding ends of said elements respectively nesting within one of said recesses, said elements extending diagonally from said recesses, individual supporting means disposed adjacent the ends of said elements remote from said recesses, individual springs for said elements, one end of each of said springs being supported from one of said ridges, and the opposite end of each of said springs being supported respectively by said individual supporting means, each of said springs being formed to engage its associated bridging element intermediate the ends thereof, a second contact member having a contact face for simultaneously engaging said remote ends of said elements, and means for producing a circuit-closing pressure between said contact members, said springs yielding to permit wiping engagement of the respective ends of said elements with said contact members.

7. In an electrical circuit interrupter, a bridging element having an off-set portion adjacent a rounded end thereof, a contact member associated with said rounded end and having a ridge overlapping the same, means including a spring engaging said off-set portion to retain said element beneath said ridge and a support loosely retaining said means in a predetermined position.

8. In an electrical circuit interrupter, a bridging element, an arcuate leaf spring for supporting said element, one end of said spring having a shoulder, means engaging said shoulder to prevent movement of said corresponding end of said spring, and means slidably supporting the opposite end of said spring.

9. In an electrical circuit interrupter, a support, a bridging element, an arcuate leaf spring, the central portion thereof engaging said element, and the width of said spring decreasing from opposite sides of said central portion, one end of said spring having supporting arms extending at right angles to the longitudinal axis of the spring, and the opposite end of said spring engaging said support.

10. In an electrical circuit interrupter, a bridging element, an arcuate leaf spring for supporting said element, one end of said spring being curled and engaging a corresponding end of said element, the central portion of said spring being of relatively great width and gradually decreasing in width toward opposite ends thereof and means cooperating with the opposite end of said spring to hold the same in a fixed position and thereby localize movement of the spring at the opposite end thereof, and means for moving said bridging element against the bias of said spring.

11. In an electrical circuit interrupter, a bridging element, an arcuate leaf spring for supporting said element intermediate the ends thereof, one end of said spring of substantial width being curled, the cross-sectional area of said spring adjacent said end being relatively small and gradually increasing towards its center and thereafter decreasing towards its opposite end, and relatively movable contact structure for moving said bridging element against the bias of said spring.

12. In an electrical circuit interrupter, cooperating relatively movable contact structures one of which has a series of recesses disposed between a plurality of ridges, a series of rigid bridging elements extending diagonally between said contact surfaces, one end of each of said elements nesting within one of said recesses, individual supporting means associated with the opposite ends of said bridging elements, and means including individual springs, corresponding ends of which are supported by said ridges and the opposite corresponding ends of which are supported by said supporting means for opposing movement of said elements under circuit closing pressure.

13. In an electrical circuit interrupter, cooperating relatively movable contact structures one of which has a series of recesses disposed between a plurality of ridges, a series of rigid bridging elements extending diagonally between said contact surfaces, one end of each of said elements nesting within one of said recesses, individual supporting means associated with the opposite ends of said elements and disposed in staggered

relationship with respect to said recesses, individual leaf springs, the respective ends of each spring being supported from one of said ridges and one of said supporting means, for retaining said individual bridging elements beneath said ridges and for opposing movement of said elements under circuit closing pressure.

14. In an electrical circuit interrupter, cooperating relatively movable contact structures one of which has a series of recesses disposed between a plurality of ridges, a series of rigid bridging elements extending diagonally between said contact surfaces, one end of each of said elements nesting within one of said recesses, individual supporting means associated with the opposite ends of said elements and disposed in staggered relationship with respect to said recesses, and individual leaf springs, the intermediate portions of which are diamond-shaped and the respective ends of each spring being supported from one of said ridges and one of said supporting members, at least one end of each spring being slidable with respect to its support, and the intermediate portion of each spring being curved upwardly and yielding to permit its associated element to wipe said structures under circuit closing pressure.

15. In an electrical circuit interrupter, a contact block, a plurality of bridging elements extending at an angle therefrom, a plurality of ridges individual thereto and forming stops to prevent movement of the inner end of each element under influence of magnetic forces, individual springs, corresponding ends being supported from said ridges, individual means for supporting the opposite ends of said springs, and a contact member for engaging the outer ends of said elements, said springs yielding to permit said elements to wipe said block and said contact member under circuit closing pressure.

16. In an electrical switch a conducting block having a plurality of parallel slots in one surface thereof, a plurality of rigid conducting elements each having one edge pivotally resting in one of said slots, said elements extending substantially parallel therefrom, means for retaining said elements in said slots and limiting the pivotal movement thereof, a conducting member movable relative to said block and said elements, and means biasing said elements into engagement with said block and said member in one position of said member.

17. In an electrical circuit interrupter, having relatively movable conducting members, rigid elements, the opposite ends of which respectively engage said members for carrying current therebetween, individual spring-supports for said elements comprising a substantially plane member with flanges at opposite edges thereof, each flange having at least one slot, and individual leaf springs each having portions at the respective ends passing through said slots and a central portion engaging an associated one of said elements.

18. In an electrical circuit interrupter, cooperating relatively movable contact structures, a plurality of rigid conducting elements, opposite edges of which, in the closed-circuit position of the interrupter, respectively engage said structures to form a bridging electrical connection therebetween, the current path in each structure being at a substantial angle to the direction of the current path through said elements, and resilient means biasing said opposite edges of said elements toward the outsides of said respective angles and yielding to permit said edges to wipe said structures under circuit closing pressure, said structures respectively having portions forming stops to prevent movement of said elements toward the outside of said angle.

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