

Jan. 28, 1936.

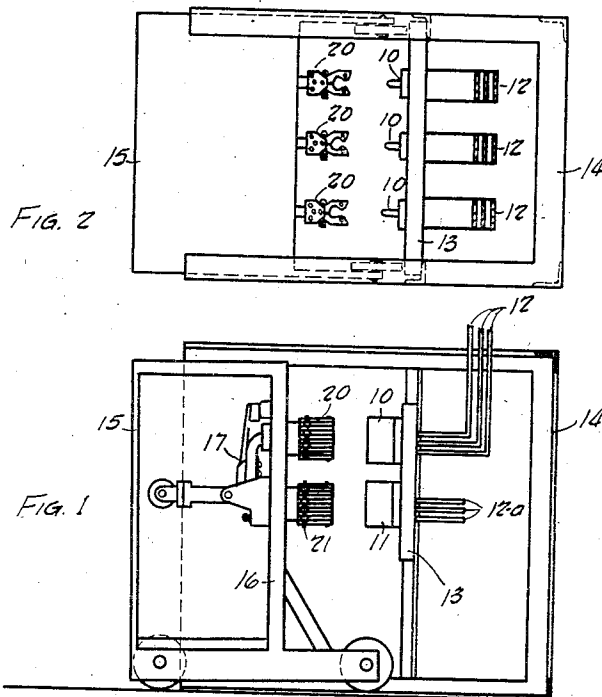
E. KNEASS ET AL

2,029,028

ELECTRIC CIRCUIT INTERRUPTER AND SEPARABLE CONTACTS THEREFOR

Filed Feb. 15, 1934

4 Sheets-Sheet 1



INVENTORS
Edward Kneass
and Otto Jensen
BY
Cornelius L. Christ
their ATTORNEY.

Jan. 28, 1936.

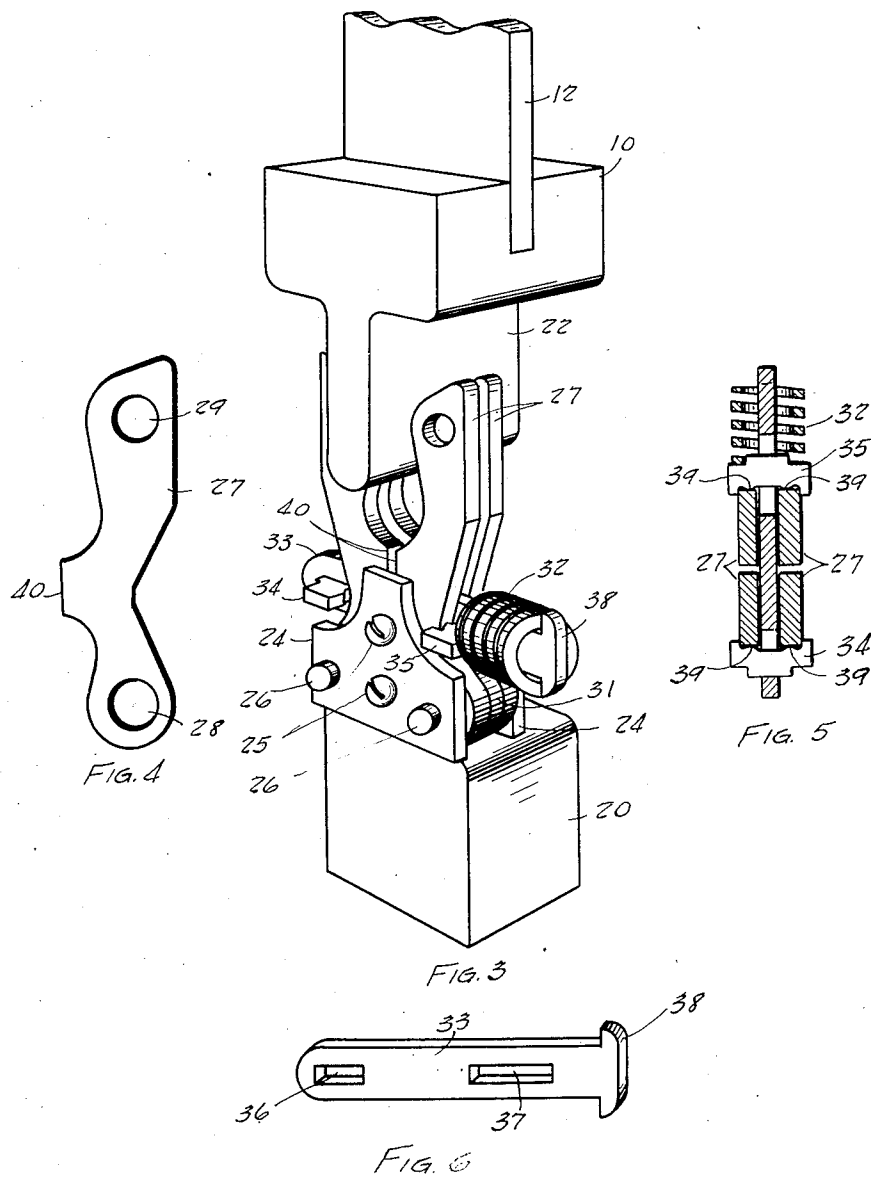
E. KNEASS ET AL

2,029,028

ELECTRIC CIRCUIT INTERRUPTER AND SEPARABLE CONTACTS THEREFOR

Filed Feb. 15, 1934

4 Sheets-Sheet 2



INVENTORS
Edward Kneass and
Otto Jensen
BY
Clement L. Ebert
their ATTORNEY.

Jan. 28, 1936.

E. KNEASS ET AL

2,029,028

ELECTRIC CIRCUIT INTERRUPTER AND SEPARABLE CONTACTS THEREFOR

Filed Feb. 15, 1934

4 Sheets-Sheet 3

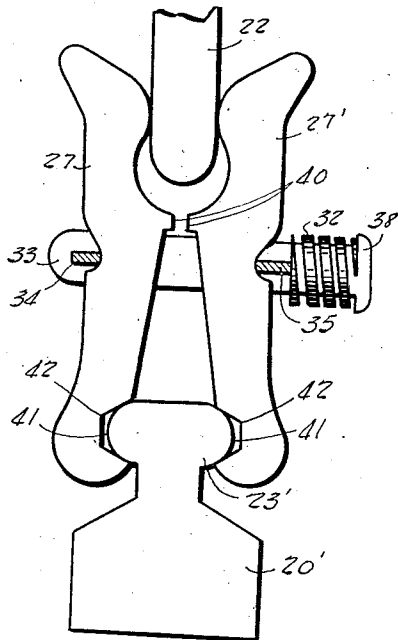


FIG. 9

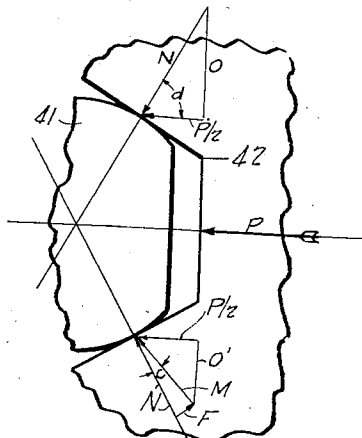


FIG. 10

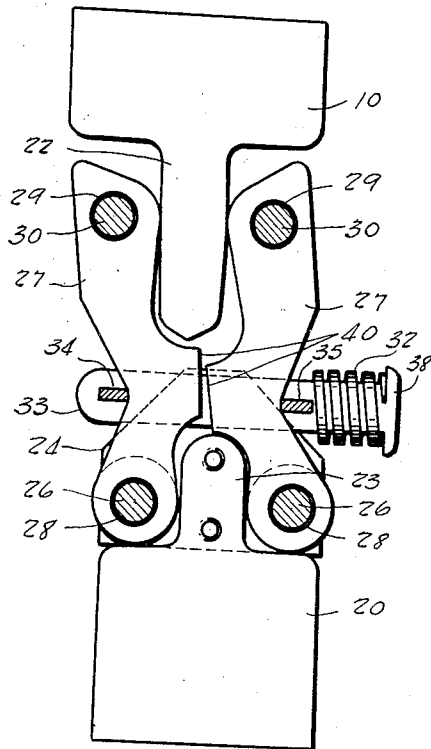


FIG. 7

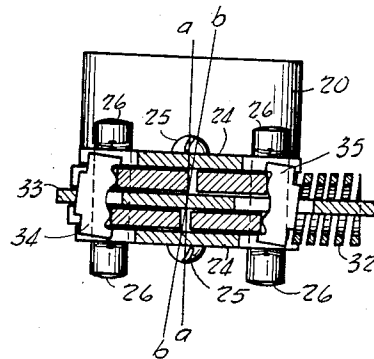


FIG. 8

INVENTORS
Edward Kneass
and Otto Jensen
 BY
Clarence L. Ebert
 their ATTORNEY.

Jan. 28, 1936.

E. KNEASS ET AL

2,029,028

ELECTRIC CIRCUIT INTERRUPTER AND SEPARABLE CONTACTS THEREFOR

Filed Feb. 15, 1934

4 Sheets-Sheet 4

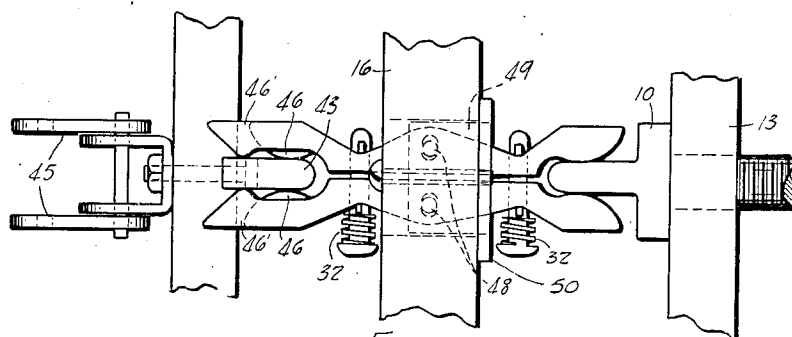


FIG. 12

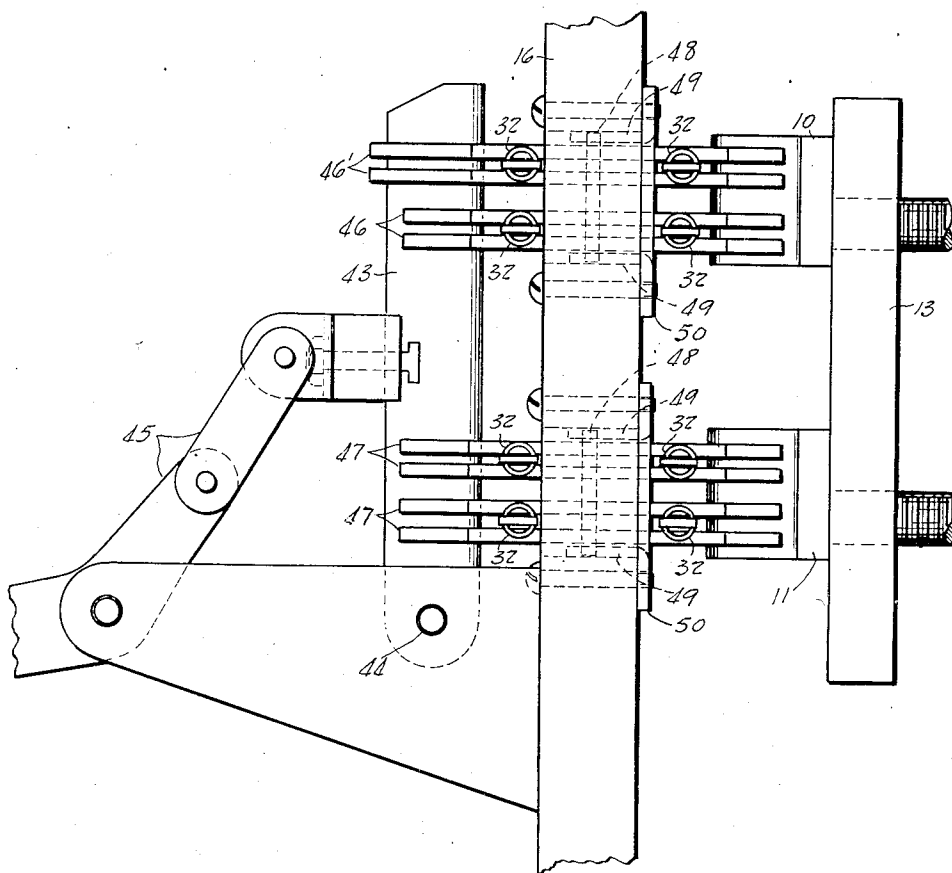


FIG. 11

INVENTORS

Edwards Kneass

and Otto Jensen

BY

Cornelius S. Ebert
their ATTORNEY.

UNITED STATES PATENT OFFICE

2,029,028

ELECTRIC CIRCUIT INTERRUPTER AND
SEPARABLE CONTACTS THEREFOR

Edwards Kneass and Otto Jensen, Philadelphia,
Pa., assignors to I-T-E Circuit Breaker Com-
pany, Philadelphia, Pa., a corporation of New
Jersey

Application February 15, 1934, Serial No. 711,315

20 Claims. (Cl. 200—166)

Our invention relates to electric circuit inter-
rupters and more particularly to new and im-
proved separable contacts therefor. While our
invention is of general application, it is particu-
larly suitable for use with circuit interrupters of
the type known in the art as disconnecting
switches.

In the art of electric circuit interrupters, it is
well known that if the cooperating separable con-
tacts are rigid metallic elements, any appreciable
misalignment between the contact surfaces, due
to inaccuracies of manufacturing or assembly,
or due to wear or other unforeseen causes, results
in unequal pressure distribution throughout the
contact surfaces and, in extreme conditions, in
single-point contact. Among well-known con-
sequences of faulty contacts is localized over-
heating which may result in welding of the con-
tacts.

It has been proposed heretofore to avoid the
abovementioned difficulties by the use of resilient
current-carrying elements, preferably comprising
a plurality of independent strips or laminations,
each of which adjusts itself to any surface ir-
regularities of a cooperating rigid contact ele-
ment. It has also been proposed to utilize coop-
erating rigid contact elements, one of which is
mounted with limited freedom of motion so that
it may adjust itself to any irregularities of the
stationary contact element, and connecting the
flexibly mounted rigid element with external
circuit terminals through flexible conducting
leads or pigtails. However, both of these arrange-
ments of the prior art have their attendant dis-
advantages. In the case of the resilient current-
carrying elements, excess currents occasioned
by heavy overloads or short-circuits, may raise
the temperature of the elements to such a point
that they lose their resilience. On the other hand,
the flexible leads utilized with cooperating rigid
elements tend to fail by fatigue when subjected
to frequent operation over a period of time.

It is an object of our invention, therefore, to
overcome the above-mentioned disadvantages of
the arrangements of the prior art and to provide
a new and improved electric circuit interrupter
and separable contacts therefor which is simple,
reliable and flexible in operation, rugged in struc-
ture and economical to manufacture.

It is another object of our invention to pro-
vide new and improved separable contacts for an
electric circuit interrupter which are provided
with a plurality of points of engagement and in
which equal contact pressures are maintained at
these several points of engagement.

It is another object of our invention to pro-
vide new and improved separable contacts for an
electric circuit interrupter which are substantial-
ly unaffected by high temperature operation oc-
casioned by short-circuits or substantial overloads
in a circuit in which the interrupter is connected.

It is a further object of our invention to provide
new and improved separable contacts for an
electric circuit interrupter in which there are in-
cluded no flexible or resilient current-carrying
elements, but in which current is carried entirely
between rigid conducting elements.

It is a still further object of our invention to
provide new and improved separable contacts for
an electric circuit interrupter which shall be sub-
stantially unaffected by misalignment of the co-
operating contacts.

In accordance with our invention in its broadest
aspects, an electric circuit interrupter is provided
with a pair of cooperating contact elements nor-
mally symmetrical about a common plane, but
subject to appreciable misalignment occasioned
by manufacturing or assembly inaccuracies. Each
of the contact elements is provided with op-
posed contact surfaces and there are provided
also a pair of rigid conducting bridging elements
or contact members, the elements or members
being disposed to engage opposing surfaces of
said contact elements in circuit-closing position
of the interrupter. A biasing spring forces the
bridging elements into engagement with the op-
posing surfaces of the contact elements to ensure
adequate and equal contact pressures at the
several points of contact. In certain instances,
it may be desirable to utilize a plurality of pairs
of bridging elements or contact members, in which
case we prefer to exert the spring pressure upon
the bridging elements through an equalizing link.

For a better understanding of our invention,
together with other and further objects thereof,
reference is had to the following description
taken in connection with the accompanying draw-
ings, and its scope will be pointed out in the ap-
ended claims.

Referring now to the drawings, Fig. 1 illus-
trates in elevation an embodiment of our inven-
tion in an electric disconnecting switch of the
truck-panel type, while Fig. 2 is a plan view of
the same apparatus;

Fig. 3 is a detailed perspective of the improved
cooperating contact elements utilized in Figs. 1
and 2, while Figs. 4, 5 and 6 show several details
of the contact assembly of Fig. 3;

Figs. 7 and 8 represent the improved contact

assembly of Fig. 3 when subjected, respectively, to horizontal and angular misalignment;

Fig. 9 illustrates a modified form of our improved separable contacts, while Fig. 10 is a force diagram to aid in the understanding of the apparatus illustrated in Fig. 9;

Fig. 11 is a view in elevation of a portion of a disconnecting switch, as illustrated in Figs. 1 and 2, modified to include also a circuit breaker, and Fig. 12 is a fragmentary plan view of the same apparatus.

Referring now more particularly to Figs. 1 and 2, there is illustrated an electric disconnecting switch of the truck-panel type utilizing our improved separable contacts. In these figures the circuit interrupter comprises stationary contact elements 10 and 11 connected to external conductors or bus-bars 12 and 12a, respectively, and mounted upon a supporting insulating panel 13 forming a part of the rigid enclosing housing 14. Cooperating with the stationary contacts 10, 11 is a movable truck 15, of conventional type, provided with a supporting insulating panel 16 on which are mounted movable contact elements 20 and 21, registering with the stationary contacts 10 and 11, respectively. The contact elements 20 and 21 may be directly interconnected, if it is desired to utilize the apparatus solely as a disconnecting switch, or these two contact elements may be interconnected through any suitable circuit breaker mechanism, represented schematically at 17.

For a better understanding of the details of our cooperating movable and stationary contacts 10 and 20, reference is had to Fig. 3. As there illustrated, the stationary contact element 10 is provided with a projecting tongue 22 with opposed parallel contact surfaces. The movable contact element 20 is provided with a similar projecting tongue 23 (Fig. 7) also having opposed parallel contact surfaces. The contact elements 10 and 20 are normally symmetrical about a common plane including their longitudinal axes. Supported from the tongue 23 are brackets 24 secured thereto by suitable screws 25. Extending between the brackets 24 are pivot pins 26 upon which are mounted two pairs of opposing rigid conducting bridging elements or contact members 27 having arcuate contact surfaces at each end and so disposed, as illustrated, as to engage edge-wise the opposing contact surfaces of the contact elements 10 and 20 when moved into circuit-closing position. The bridging elements 27 may be punched blades or laminations, or any suitable rigid conducting elements.

To provide a loose pivotal mounting, the bridging elements 27 are provided with holes 28 and 29 adapted, respectively, to engage the pivot pins 26 and also, if desired, upper aligning pins 30 (Fig. 7) which have been omitted from Fig. 3 for the sake of clarity. The holes 28, 29 are somewhat larger than their associated pins, as shown more clearly in Fig. 7, to allow a limited freedom of motion of the bridging elements 27 with respect to their associated pins. If desired, spacing washers 31 may be interposed between corresponding bridging elements 27 of the two pairs.

The opposed finger contact members or bridging elements 27 of each pair are biased toward each other, and thus into pressure engagement with the opposed contact surfaces of the contact elements 10 and 20, by a suitable biasing spring 32, operating through a link 33 and a pair of equalizing yokes 34 and 35. As illustrated, the yokes 34 and 35 are supported in the slots 36 and

37, respectively, (Fig. 6) of the link 33, while the link 33 is provided with a head 38 for retaining the spring 32. The manner in which these biasing elements are assembled is shown in detail in the cross-sectional view of Fig. 5. As shown in this figure, the inner surfaces of the yokes 34 and 35 engaging the bridging elements 27 are formed into projections 39 of a relatively small radius or, if desired, into knife edges, to insure equalization of the biasing forces on the several bridging elements 27 under conditions of misalignment of the contact elements 10 and 20, as described more fully hereinafter. The bridging elements 27 are preferably provided with stop surfaces 40 to limit the motion of opposed elements of each pair toward each other under the influence of the biasing spring 32 when disengaged from the stationary contact element 10. By thus maintaining a minimum separation and by flaring the upper ends thereof, an easy entrance of the projecting tongue 22 of the contact element 10 between opposed bridging elements 27 is ensured.

The manner in which the above-described apparatus operates in response to movement of the contact elements 10 and 20 toward and away from each other will be readily apparent to those skilled in the art.

In brief, assuming the contact elements 10 and 20 are in circuit-opening position, as shown in Figs. 1 and 2, the biasing spring 32 will force the opposing bridging elements 27 into engagement at their stop surfaces 40, leaving, however, a substantial space between their upper contact surfaces. As the contact elements 10 and 20 are moved toward each other, the tongue 22 of the contact element 10 enters between and forces apart the upper ends of opposing bridging elements 27. Due to the limited freedom of motion between the elements 27 and the pivot pins 26, as described above, the lower contact surfaces of the elements 27 directly engage the opposing contact surfaces of the projecting tongue 22 of the contact element 20, the yokes 34 and 35 of the biasing spring assembly acting as pivot points. At the same time these yokes 34 and 35 serve to equalize the pressure of the biasing spring 32 between the corresponding bridging elements 27 of the two pairs, effectively biasing the several bridging elements individually into wiping and rolling engagement with the contact surfaces of the elements 10 and 20 and providing therebetween a low resistance current path independent of the pivot pins 26. Thus, the single biasing spring 32 serves to produce exactly equal contact pressures at each of the points of contact of the bridging elements 27 with the contact surfaces of the elements 10 and 20, provided that the biasing spring 32 and its associated linkage acts substantially midway between the upper and lower contact surfaces of each of the bridging elements 27, which is the preferred arrangement. It will be noted that the biasing spring 32 not only carries no current, but is in such position as to radiate any heat conducted thereto at a maximum rate, so that the effect of abnormal currents upon its resilience is substantially eliminated.

While we have illustrated our invention as applied to an apparatus employing only two pairs of opposed bridging elements 27, it will be apparent that any desired number of these bridging elements may be employed, a plurality of these assemblies being indicated in Fig. 1 of the drawings.

As stated above, the stationary and movable contact elements 10 and 20 are normally sym-

metrical about a common plane. However, the contact elements of an electric circuit interrupter are often subjected to appreciable misalignment due to inaccuracies of manufacture or assembly, or to irregularities in wearing of the contact surfaces, or other causes. These misalignments may be transverse in parallel planes, or may be of the nature of a relative angular rotation between the cooperating contact elements, or a combination of the two. By the term "appreciable misalignment" we refer, throughout this specification and the appended claims, to any such misalignment, either transverse or angular, as would substantially interfere with the quality of electrical contact between two rigid cooperating contact elements; it, of course, being clearly understood that extremely minute degrees of misalignment may produce very substantial detrimental effects on the conductance between the two rigid contact elements.

In Fig. 7 are depicted the conditions resulting from a transverse misalignment; that is, when the axial plane of the contact element 10 is moved transversely but parallel to the axial plane of the contact element 20. Under these conditions, it is seen that the bridging elements 27 rotate about the pivot pins 26 in a counter-clockwise direction, maintaining substantially equal contact pressures, however, at the points of engagement of their contact surfaces with the opposed contact surfaces of the elements 10 and 20. This results from the fact that the bridging elements 27 are provided with upper and lower arcuate contact surfaces which, in effect, roll along the opposed contact surfaces of the elements 10 and 20 as they are moved transversely with respect to each other.

The conditions resulting from an angular misalignment of the contact elements 10 and 20 are shown in Fig. 8 in which the line *a-a* represents the trace of the common plane of symmetry of the two contact elements when in proper alignment, while the line *b-b* represents the trace of the plane of symmetry of the upper contact 10 when subjected to an appreciable angular misalignment. Under these conditions, the yoke members 34 and 35 adjust themselves to the positions indicated, allowing the two pairs of opposed bridging elements to take up different angular positions. Due to the knife edge or equivalent contact between the yokes 34 and 35 of the bridging elements 27, the pressure of the biasing spring 32 is substantially equalized between the several bridging elements to maintain equal contact pressures of the several points of contact. If desired, the inner edges of the bridging elements may be made slightly convex to improve the contact conditions upon an angular misalignment of the contact elements.

Referring more particularly to Fig. 7, it is seen that each of the bridging elements 27 has its movement toward the plane of symmetry of the terminal 20 limited by the projecting tongue 23 and the stop surfaces 40. When the contact assembly is made up of a plurality of groups of opposing bridging elements 27 as, for example, shown in Fig. 1, it is possible, under certain conditions, upon the disengagement of the contact elements 10 and 20, for adjacent groups of bridging elements to take positions on opposite sides of the plane of symmetry of the stationary contact 10. In order substantially to avoid such a condition, which would render difficult the entry of the tongue 22 of the contact element 10 between the groups of opposing bridging elements,

the aligning pins 30 are inserted in the upper holes 29 of the bridging elements 27 to maintain the adjacent groups of these elements in approximate alignment. A loose fit is provided for these pins in the holes 29. Upon the disengagement of the stationary and movable contact elements 10 and 20, the bridging elements 27 are stable in any position of misalignment, either transverse or angular. Thus, when utilized in a truck-type disconnecting switch, as shown in Figs. 1 and 2, the reengagement of the contact elements is facilitated, since the bridging elements 27 remain in the particular condition of misalignment obtaining upon the separation of the contact elements.

The biasing spring 32 and associated link preferably engage the bridging elements 27 between their points of engagement at the stop surfaces 40 and the tongue 23. With such an arrangement, upon the disengagement of the contact elements, the pivot pins 26 and aligning pins 30 may be removed and the biasing spring 32 and link 33 will maintain the bridging elements in position. Any faulty group of bridging elements 27 may then be removed, by simply pinching together their upper ends, without disturbing the remaining bridging elements. In brief, any particular group of elements may be replaced or repaired without completely disassembling the whole contact unit.

In Fig. 9 is illustrated a modified form of our improved cooperating contacts in which the contact element 20 is replaced by a contact element 20' having an extending tongue 23' provided with opposed cylindrical projections 41 or projections having at least two segmental cylindrical surfaces. The rigid conducting bridging elements 27 are, in this instance, replaced by the elements 27' which are similar except for the fact that the pivotal hole in one end of each is replaced by recesses 42 registering with one of the projections 41 of the contact element 20'. The sides of the recesses 42 comprise plane surfaces disposed at an angle to each other so that when contact is made with the cylindrical projections 41, substantially line contacts are formed between each of the plane surfaces and the cylindrical surface tangent thereto.

In this instance, the biasing spring 32, together with its associated link 33 and yokes 34 and 35, are disposed nearer the upper contact surfaces of the bridging elements 27' than the lower contact surfaces, for reasons pointed out hereinafter. In this arrangement, also, the slots 36 and 37 in the link 33 are preferably of such dimensions as to limit the outward movement of the opposing bridging elements 27' when engaging the contact surfaces of the projection 22 of the element 10, so that the recesses 42 will not clear the projections 41 when subjected to the longitudinal thrust of engagement or disengagement. In this way the elements 27' are effectively locked to the contact element 20' and may not be withdrawn by sticking or slight welding of the contact surfaces of the contact element 10 and the contact surfaces of the bridging elements 27'.

The particular form of the recesses 42 and the projections 41, described above, are effective to increase the contact pressures at the contact element 20'. This may be understood more readily by reference to Fig. 10, which constitutes a force diagram at the contact surfaces. Considering perfectly rigid contact surfaces, so that friction may be neglected, the contact pressures at the points of contact are normal to the plane of

contact; that is, normal to the plane surfaces constituting the sides of the recesses 42. The force acting at one of these points of contact is represented by the vector N. In this same figure the vector P represents the force applied by the biasing spring 32 at the lower contact surface of an element 27'. Since there are two points of contact, this force divides itself equally and the component effective at a particular point of contact is represented by the vector P/2. Since the angle α between the forces N and P/2 is dependent upon the geometry of the parts, the magnitude of the force N is thereby determined. The force represented by the vector O would, of course, be equalized by an equal and opposite force at the other contact surface.

In the case of actual contact surfaces, however, they are not ideally rigid, with the result that there is a slight deformation at the contact surfaces resulting in an infinitesimal sliding of the surfaces which introduces the element of friction. In the lower portion of the diagram of Fig. 10, the vector F represents the reacting frictional force and is equal to the normal pressure times the tangent of the angle c , which corresponds to the coefficient of friction and is determined solely by the properties of the contact surfaces. Under these circumstances, the vector M represents the actual contact pressure between the contact surfaces, which is somewhat less than the force N in the ideal case. Obviously, these conditions will obtain at the upper contact surface of Fig. 10, rather than the ideal conditions described above. The two opposing forces O' have the effect of raising or lowering the recesses 42 relative to the projections 41 to secure equalization of the pressures at the two points of contact.

With the design of the contact just described, the arithmetical sum of the contact pressures at the two contact surfaces of each projection 41 and its registering recess 42 is greater than the applied force P and, therefore, the current-carrying capacity between the two elements, which is a function of the contact pressure, is thereby increased. Since the rating of the circuit interrupter, of which the above-described contact elements form a part, is limited by that contact surface having the lowest current-carrying capacity, to secure an equalization of the current-carrying capacities of the contact elements of Fig. 9, the biasing spring 32 is moved away from the recesses 42 beyond the midpoint between the contact surfaces of the bridging elements 27' so that the applied force at the upper contact surfaces, as referred to in Fig. 9, is greater than that applied to the lower contact P, which have the amplifying effect described above. It will be readily apparent that the full cylindrical surfaces 41, as shown in Fig. 9, and the segmental cylindrical surfaces of Fig. 10 are full equivalents and may be selected as desired. It will also be readily apparent that the cylindrical projections and angular recesses may be replaced by cylindrical projections on the bridging elements 27' and cooperating recesses in the contact element 28'.

Figs. 11 and 12 are fragmentary views in elevation and plan, respectively, of a modified form of the truck type electric disconnecting switch shown in Figs. 1 and 2. In this case, the stationary contacts 10 and 11 mounted on the insulating supporting panel 13 are, in all respects, similar to those of Fig. 1. In this case, however, the circuit breaker represented schematically at 17, in Fig. 1, is replaced by a rigid bridging member

43 including two distinct contact elements or a single continuous contact element, as illustrated, and having opposed contact surfaces analogous to those of the contact elements of the assemblies 20 and 21 of Fig. 1. The conducting blade or member 43 is pivoted at 44 in a suitable frame supported from the insulating panel 13 and is adapted to be operated into circuit-opening and circuit-closing positions either manually or automatically, as desired, by any suitable mechanism indicated schematically as a linkage mechanism 45. In this case the bridging elements 27 of Fig. 3 are replaced by a modified form of bridging elements 46, 46' and 47 which are essentially elements having both ends similar to the upper ends of elements 27, as shown in Fig. 3. The uppermost bridging elements 46' of Fig. 11 are similar to the others except for the fact that they extend beyond the bridging elements 46 cooperating with the same stationary contact element 10 and may be composed of any suitable low resistance arc-resistant material, so that the contact is broken at the elements 46' rather than at 46, thus minimizing arcing and its effects at the contact elements 46, which are of conducting material of minimum resistance.

The bridging elements 46 and 46' are loosely pivoted on the pins 48 carried by inwardly extending projections 49 of brackets 50 secured to the insulating panel 13. A pair of biasing springs and associated linkage mechanisms are provided for each two pairs of opposed bridging elements, one on each side of the supporting panel 13.

In this modification, which comprises a combined circuit breaker and disconnecting switch, the circuit is completed between the stationary contact elements 10 and 11 with a minimum number of cooperating contact surfaces in series. For example, in the arrangement of Fig. 1, in the path between the contact elements 10 and 11, are included the contact surfaces of the elements 10; the contact surfaces of the elements 20; the two contact surfaces of the bridging circuit breaker 17; the contact surfaces of the elements 21, and the contact surfaces of the elements 11. In the arrangement of Figs. 11 and 12, however, the contact surfaces of the elements 20, 21 and the bridging circuit breaker 17 are combined into the contact surfaces between the bridging elements 46, 46' and 47 and the rigid bridging member 43, thus eliminating two groups of contacts in series.

While we have illustrated our invention as embodied in electric circuit interrupters employing two or four pairs of rigid conducting bridging elements between cooperating contact elements, it will be obvious to those skilled in the art that any desired number of such bridging elements may be employed in accordance with the current-carrying requirements of the interrupter of which they form a part, and that while we have illustrated our invention as applied to a 3-pole circuit interrupter, it is equally applicable to electric switches or interrupters of any number of poles.

While we have described what we at present consider the preferred embodiment of our invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the spirit of our invention; and we, therefore, aim in the appended claims, to cover all such changes and modifications as fall within the true spirit and scope of our invention.

What we claim is:

1. In an electric switch relatively movable

contact structures one of which comprises a pair of bridging elements, mounting means providing independent limited freedom of movement for each of said elements, a conducting member disposed between said bridging elements and provided with contact surfaces independent of said mounting means arranged to be engaged by the corresponding bridging elements, another of said movable contact structures positioned between said bridging elements in the closed circuit position, and a spring interconnecting said elements intermediate the ends thereof and in spaced relation from said conducting member and said other of said movable contact structures when in said circuit closing position for biasing said bridging elements into engagement with said other of said movable contact structures and into wiping and rolling engagement with said conducting member.

2. In an electric switch, contact structure comprising bridging elements, mounting means providing independent limited freedom of movement for each of said elements, a conducting member disposed between said bridging elements and provided with contact surfaces independent of said mounting means arranged to be engaged by the corresponding bridging elements, said elements being movable toward and into engagement with each other intermediate the ends thereof, said elements having recesses opposite their region of engagement, rigid means operatively engaging said elements in said recesses, a spring cooperating with said rigid means for biasing said elements toward each other and for biasing said elements into rolling and wiping engagement with said conducting member, and a contact positioned between said elements in the closed circuit position, said spring also biasing said elements into engagement with said last named contact.

3. In an electric circuit breaker, contact structure comprising a conductor having contact surfaces, contact elements having contact surfaces disposed for engagement with said surfaces of said conductor, means for mounting said elements on said conductor for their individual limited freedom of movement with respect to said conductor and for conduction of the current through the circuit breaker by said elements substantially independently of said mounting means, a contact arranged to be engaged by said contact elements in the closed circuit position of the circuit breaker, and means resiliently biasing said contact elements into wiping engagement with said contact, said resilient means also biasing said contact elements into wiping engagement with said conductor.

4. In an electric switch, contact structures relatively movable and either of them subject to appreciable departure from a predetermined path, one of said structures comprising bridging elements, means providing a loose pivotal mounting for each of said elements, a conducting member disposed between said bridging elements and provided with contact surfaces independent of said pivotal mounting and arranged to be engaged by the corresponding bridging elements, another of said movable contact structures positioned between said bridging elements in the closed circuit position, each of said elements upon departure of said other of said movable contact structures from a predetermined path being movable on said pivotal mounting to a new position determined by the extent and direction of said departure, and means for retaining said elements in said new position comprising portions thereof

coming into engagement with each other as said other of said movable contact structures moves to open circuit position, and a spring for biasing said portions of said elements into said engagement and for biasing said elements into engagement with said other of said movable contact structures and into wiping and rolling engagement with said conducting member.

5. In an electric switch, a contact structure comprising a plurality of pairs of similar bridging laminations, mounting means providing independent limited freedom of movement of said laminations, a conducting member disposed between said bridging laminations and provided with opposed contact surfaces independent of said mounting means arranged to be engaged by the edges of corresponding bridging laminations, a second contact positioned between said bridging laminations in the closed circuit position, and a link, one end of which is operatively associated with the laminations in engagement with one of said opposed surfaces and the opposite free end of said link extending substantially at right angles to said laminations and beyond those laminations in engagement with the other of said opposed surfaces, a spring external to said bridging laminations and operatively associated with the said free end of said link for biasing all of said bridging laminations into wiping engagement with said second contact and into wiping and rolling contact engagement with said conducting member.

6. In an electric switch, contact structure comprising a plurality of bridging elements, means providing a loose pivotal mounting for each of said elements for a limited freedom of movement of each of said elements, a conducting member disposed between said bridging elements and provided with contact surfaces independent of said pivotal mounting arranged to be engaged by corresponding bridging elements, a second contact provided with contact surfaces arranged to be engaged by bridging elements in the closed circuit position, resilient means including equalizing means for biasing said elements substantially equally irrespective of the position of each element within its limited freedom of movement into wiping contact with said second contact and into wiping engagement with said conducting member.

7. In an electrical apparatus, two axially aligned contact members each having two opposed contact surfaces on the outer surfaces thereof, four rigid bridging elements, the first two of said elements engaging corresponding surfaces of each of said contact members and the second two of said elements engaging the opposite corresponding surfaces, and equalizing means including a spring for producing equal bias on each of said rigid elements in a direction to maintain said elements in pressure-engagement with said contact members.

8. In an electric switch, a pair of cooperating relatively movable contact elements normally symmetrical about their plane of relative motion but subject to appreciable misalignment therefrom, each of said elements having opposed contact surfaces, a plurality of pairs of rigid conducting bridging elements symmetrically supported from one of said contact elements with independent limited freedom of movement, the elements of each pair being disposed to engage opposing surfaces of said contact elements in circuit-closing position of said switch, spring means directly interconnecting the bridging ele-

ments for biasing the same into said engagement, and stop means disposed on said bridging elements for limiting the movement thereof under the influence of said biasing means in circuit-opening position of said switch, whereby said bridging elements will maintain a misalignment corresponding to that of the contact elements upon their operation to circuit-opening position.

9. In an electric switch, a pair of cooperating contact elements, a similarly disposed pair of rigid conducting bridging elements for interconnecting said contact elements in circuit-closing position of said switch, a spring disposed to bias said bridging elements into engagement with said contact elements, and an equalizing yoke interposed between said spring and said bridging elements for procuring substantially equal contact pressures at all points of contact.

10. In an electric switch, a pair of cooperating contact elements each having opposed contact surfaces, a plurality of pairs of rigid conducting bridging elements, the elements of each pair being disposed to engage opposing surfaces of said contact elements in circuit-closing position of said switch, spring means disposed to bias said bridging elements into said engagement, and equalizing yokes interposed between said spring means and corresponding bridging elements of said pairs for procuring an equal bias on each of said bridging elements thereby to insure substantial contact pressures at all points of contact.

11. In an electric switch, a pair of cooperating contact elements normally symmetrical about a common plane but subject to appreciable misalignment, each of said elements having opposed contact surfaces, a plurality of pairs of rigid conducting bridging elements, the elements of each pair being disposed to engage opposing surfaces of said contact elements in circuit-closing position of said switch, and means for biasing said bridging elements into engagement with said contact elements comprising a link member interposed between said pairs of bridging elements, a pair of yoke members each engaging corresponding elements of said pairs and supported by said link member, and a spring threaded on said link and biasing said yokes toward each other, whereby equal bias is applied to all bridging elements thereby to insure substantial contact pressures at all points of contact between said bridging elements and said contact elements.

12. In an electric switch, a pair of cooperating contact elements each having opposed contact surfaces, a pair of rigid conducting bridging elements disposed to engage opposing surfaces of said contact elements in circuit-closing position of the switch, the contact surfaces of one end of each of said bridging elements and its associated contact element comprising complementary projections and recesses, means for biasing said bridging elements into engagement, and stop mechanism effective to limit the motion of said bridging elements against the force of said biasing means to an amount insufficient for the detachment of said bridging elements from said contact element when the switch is in an operative position but sufficient for such detachment when in an inoperative position.

13. In an electric circuit interrupter comprising a pair of stationary contact elements, a movable contact assembly comprising a supporting panel and a bridging member movable relative thereto, said bridging member including a pair of contact elements complementary to said stationary contact elements, corresponding station-

ary and movable contact elements being normally symmetrical about their plane of relative motion but subject to appreciable misalignment, each of said contact elements having opposed contact surfaces, a pair of rigid conducting bridging elements associated with each stationary contact element and its cooperating movable contact element and loosely and pivotally mounted on said supporting structure and disposed to engage opposing surfaces of said contact elements in circuit-closing position of said interrupter, and means for biasing the bridging elements into said engagement.

14. In an electric switch, a pair of cooperating contact elements normally symmetrical about a common plane but subject to appreciable misalignment, each of said elements having opposed contact surfaces, a pair of pivot pins removably supported from one of said contact elements, a plurality of pairs of rigid conducting bridging elements, corresponding elements of said pairs being similarly and loosely pivoted on one of said pivot pins and the elements of each pair being disposed to engage opposing surfaces of said contact elements in circuit closing position of said switch, and means individually for biasing the bridging elements into said engagement, said bridging elements having complementary stop surfaces cooperating with said biasing means to retain said elements in frictional engagement with the contact element on which they are pivoted upon removal of said pivot pins, whereby the bridging elements may be removed in groups without disturbing the remaining elements of the assembly.

15. In an electric circuit breaker, relatively movable contact structure comprising a pair of contact members, means providing a loose pivotal mounting for each of said members, a movable contact arranged to be engaged at opposite sides thereof by said contact members in the closed circuit position, and means resiliently biasing said members into contact engagement with said movable contact, said contact members likewise biased into contact engagement in the closed circuit position with stationary conducting means independently of said pivotal mounting.

16. In an electric circuit breaker, relatively movable contact structure comprising a pair of contact members, means providing a loose pivotal mounting for each of said members, a stationary conducting member disposed between said contact members and provided with contact surfaces independent of said pivotal mounting arranged to be engaged by the corresponding contact members, a movable contact positioned between said contact members in the closed circuit position, and means resiliently biasing said contact members into engagement with said movable contact, said resilient means likewise biasing said contact members in the closed circuit position into combined rolling and wiping contact engagement with said stationary conducting member.

17. In an electric circuit breaker, relatively movable contact structure comprising a pair of contact members, means including a pair of pins providing a loose pivotal mounting for each of said members, a conducting member to which said pins are secured, said conducting member and said contact members having coacting contact surfaces independent of said pins included in the circuit, a movable contact positioned between said contact members in the closed circuit position, and means resiliently biasing said coacting contact surfaces into direct engagement in

said closed circuit position by reason of the afore-said loose pivotal mounting.

18. In an electric circuit breaker, relatively movable contact structure comprising a stationary conducting member, a pair of contact members, means depending from opposite sides of said conducting member forming pivotal supports for said contact members, said contact members being in direct contact engagement with said conducting member in the closed circuit position, and a movable contact positioned between said contact members in said closed circuit position.

19. In an electric circuit breaker, relatively movable contact structure comprising a stationary conducting member, a plurality of pairs of oppositely disposed contact members pivotally mounted with respect to said conducting member, said contact members arranged to be in direct contact engagement with said conducting member in the closed circuit position independently of the pivotal mountings thereof, a movable conducting blade positioned between said contact members in the closed circuit position so that each side of said blade is engaged by a plurality of contact

members, and means including a spring and a member common to a pair of coating contact members for biasing said contact members individually into equalized contact engagement with said blade and into direct contact engagement with said conducting member.

20. In an electric circuit breaker, relatively movable contact structure comprising a pair of finger contact members, a relatively fixed conducting member, means loosely mounting said contact members for pivotal movement with respect to said conducting member, a movable contact positioned between said finger contact members in the closed circuit position, said finger contact members and said conducting member having coating contact surfaces independent of said pivotal mounting arranged for combined rolling and wiping engagement, and resilient means for biasing said finger contact members into engagement with said movable contact and said conducting member.

EDWARDS KNEASS.
OTTO JENSEN.