Jan. 14, 1947. R. P. HANNA ET AL 2,414,200

TROLLEY CONDUCTOR SECTION INSULATOR WITH MAGNETIC BLOWOUT

Filed Feb. 10, 1944 2 Sheets-Sheet 1

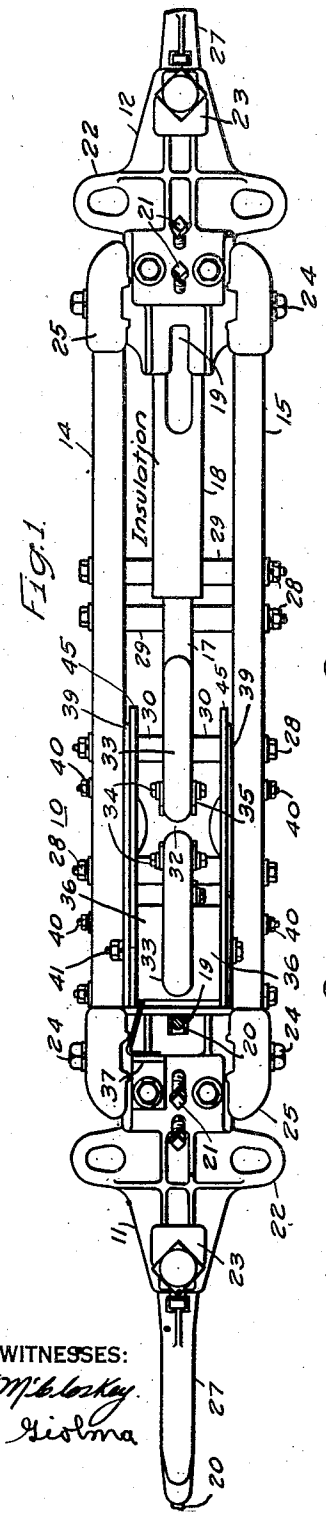

Fig. 1.

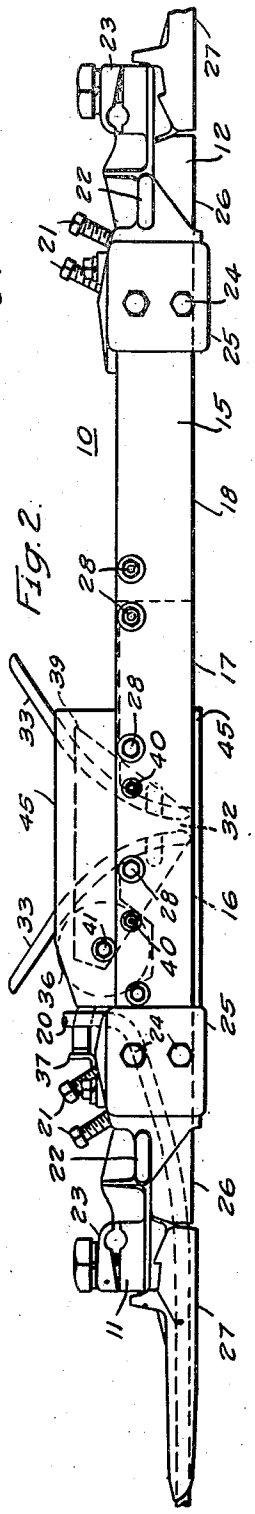

Fig. 2.

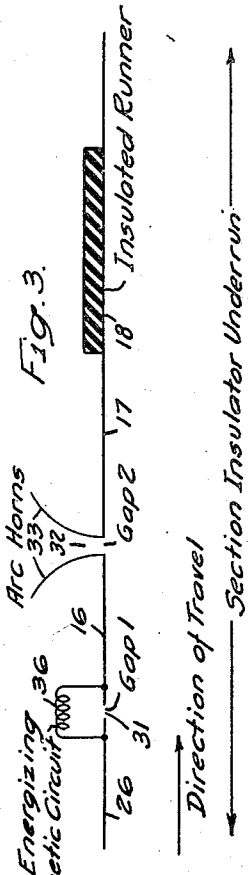

Fig. 3.

WITNESSES:
E. A. McCloskey.
C. V. Siolma

INVENTORS
Raymond P. Hanna
and Norman H. Willby.
BY
G. M. Crawford
ATTORNEY

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Fig. 4.

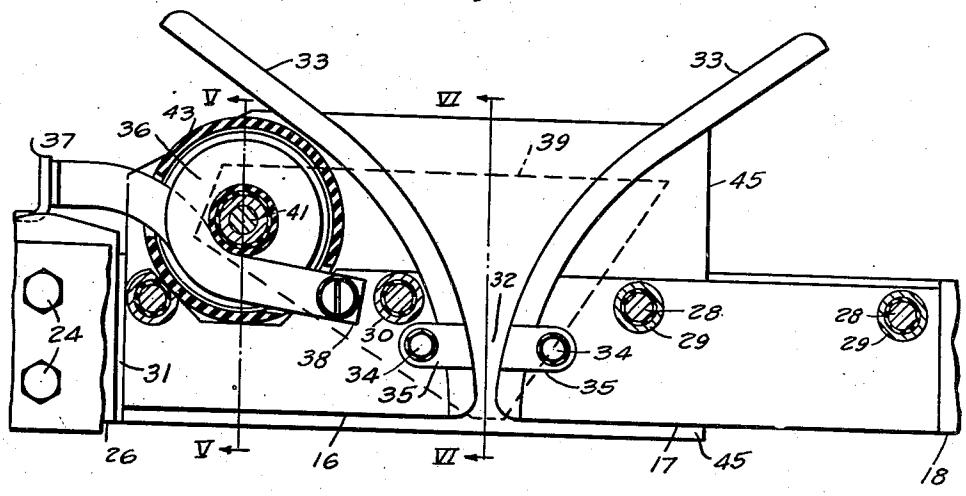


Fig. 5.

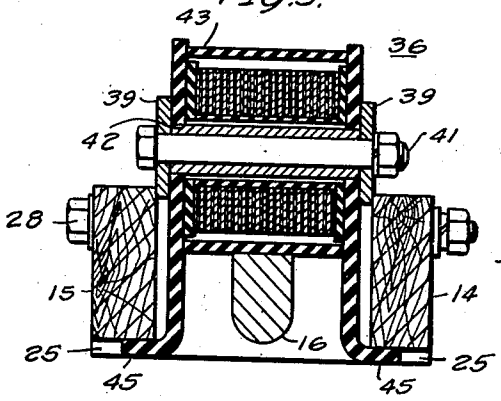


Fig. 6.

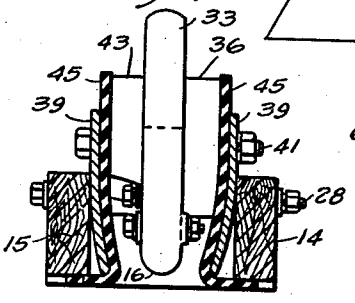
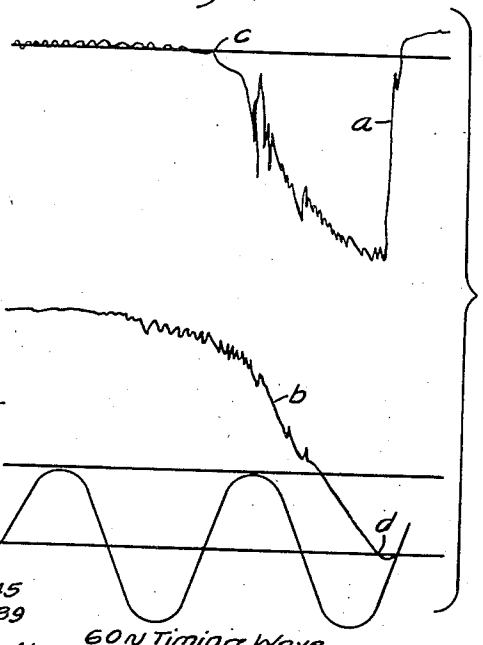


Fig. 7.



WITNESSES:

E. A. McClatchey.

F. V. Riolma

INVENTORS

Raymond P. Hanna

and Norman H. Willby.

BY

G. M. Crawford

ATTORNEY

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TROLLEY CONDUCTOR SECTION INSULATOR WITH MAGNETIC BLOWOUT

Raymond P. Hanna, Pittsburgh, and Norman H. Willby, Irwin, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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Our invention relates, generally, to trolley conductor devices and has reference, in particular, to section insulators for trolley conductor systems.

Generally stated, it is an object of our invention to provide an improved trolley conductor section insulator which is simple and inexpensive to manufacture, and is durable in operation.

More specifically, it is an object of our invention to provide for positively and rapidly extinguishing the arc drawn by a current collector shoe as it traverses a section insulator.

Another object of our invention is to provide an intensive magnetic field at the point of arcing in a section insulator at the instant or before the arc is drawn.

Yet another object of our invention is to provide a conductive path of predetermined length between a pair of spaced gaps in a section insulator, and connect an arc blowout winding across the first of the spaced gaps, for producing a magnetic field at the second gap which reaches a maximum value by the time an arc is drawn at the second gap.

Still another object of our invention is to provide for using a section insulator of the double beam type wherein the runner portion is clear of the tension members, and provide for assisting the natural tendency of an arc drawn across a gap in the runner portion to rise by using a magnetic field.

A further object of our invention is to provide for using renewable arc horns with section insulators in trolley conductor systems.

It is also an important object of our invention to provide for extinguishing an arc in a section insulator by producing a relatively concentrated magnetic field principally at the point of arcing.

Other objects will, in part, be obvious and will, in part, be explained hereinafter.

In accordance with our invention, the tendency towards increased arcing caused by higher accelerating currents and the use of carbon shoes with trolley cars and buses, is overcome by using a section insulator of the double beam type which is provided with a conductive runner portion having two gaps therein spaced a predetermined distance apart. The first gap is bridged by an arc blowout coil which sets up a magnetic flux which is concentrated at the second gap by means of a magnetic field structure. The distance between the gaps is such that the magnetic field builds up to a maximum value by the time the arc is drawn at the second gap. Removable arc horns at the second gap provide for extending the arc as it moves upward, and the magnetic field arranged to speed up the movement of the arc in the same direction so as to insure its being extinguished.

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For a more complete understanding of the nature and scope of our invention, reference may be made to the following detailed description in connection with the accompanying drawings, in which:

Figure 1 is a plan view of a section insulator embodying the principal features of the invention,

Fig. 2 is a side elevational view of the section insulator shown in Fig. 1,

Fig. 3 is a diagrammatic view of the electric circuit arrangement in the section insulator of Figs. 1 and 2,

Fig. 4 is an enlarged partial side elevational view of the section insulator shown in Figs. 1 and 2, broken out in part to show details of the coil connections and the arc horns,

Fig. 5 is an enlarged sectional view of the section insulator, taken along the line V—V of Fig. 4,

Fig. 6 is a sectional view of the section insulator drawn to a reduced scale, and taken along the line VI—VI of Fig. 4, and,

Fig. 7 illustrates current and voltage curves, showing the arc extinguishing characteristics of a section insulator embodying the invention.

Referring to Figures 1 and 2, the reference numeral 10 may denote generally, a section insulator which is designed for effecting improved operation of carbon current collector shoes therealong in the direction from left to right. The insulator may for example, comprise spaced end members 11 and 12 for effecting the connection of the device to the adjacent portions of a trolley conductor and spaced side members 14 and 15 of insulating material connected thereto to maintain the end members in predetermined spaced relation. The insulator is of the double beam type with the side members 14 and 15 in the same horizontal plane. Spaced metallic runner members 16 and 17 may be positioned between the side members in conjunction with an insulated runner member 18 for guiding a current collector.

The end members 11 and 12 may be of any suitable construction, comprising, for example, elongated body portions having upwardly inclined openings 19 therethrough for receiving the trolley conductor 20, and being provided with means such as the screws 21 for securing the trolley conductor in the openings. Laterally projecting ears 22 may be provided for supporting the section insulator in an overhead trolley conductor system, and clamp means 23 may be provided for

connecting a suitable feeder cable (not shown) thereto for energizing an adjacent section of the trolley conductor. Transverse bolts 24 may be provided for securing the insulating members 14 and 15 to the end members in conjunction with suitable cap members 25 which enclose the ends of the insulating members. Suitable runner portions 26 may be positioned on the lower sides of the end members in conjunction with approach members 27 for providing a smooth path for a current collector shoe or the like.

In order to provide for extinguishing an arc drawn by a current collector shoe or the like traversing the section insulator 10, the metallic runner members 16 and 17 may, as shown in Figs. 1, 2 and 4, be positioned between and supported by the insulating side members 14 and 15 in spaced and insulated relation to the end members and to each other by means of transverse bolts 28 and suitable spacers 29 and 30. Thus a pair of gaps 31 and 32 may be provided, which are separated by the length of the runner member 16, as shown in Figs. 3 and 4. The runner members may be provided with arc horns 33 which are curved so as to diverge upwardly and provide an upwardly diverging arc gap between the runner members for stretching any arc drawn therebetween in order to extinguish it. Since the arcs are drawn between the arc horns 33, they are preferably made renewable. They may, for example, be detachably connected to the runner members 16 and 17, being for example attached by means of bolts 34 passing through lugs 35 on the arc horns and through openings in the runner members.

As shown in the schematic diagram in Figure 3 and in Figure 4, the runner member 16 is positioned a predetermined distance from the end of the runner portion 26 of the end member 11 so as to provide a gap therebetween which may be bridged by an arc blowout coil 36 for producing a magnetic flux for forcing the arc upwardly in the gap 32 between the arc horns 33. For example, the terminals 37 and 38 of the blowout coil 36 may be connected to the end member 11 and the runner member 16, respectively. In order to produce a relatively concentrated magnetic flux in the arc gap 32, means such as the magnetic side plates 39 may be provided. The side plates 39 may, as shown in Figs. 1, 2, 4, 5 and 6, be positioned intermediate the insulating members 14, 15 and the runner members 16, 17 being, for example, secured to the insulating members by means of screws 40. The plates 39 may be tapered so as to provide a portion of relatively great width opposite the arc gap 32 in order to provide a maximum amount of magnetic flux in the arc gap. They may be connected adjacent the narrow end by means such as the transverse bolt 41, which may form a magnetic core and a support for the arc blowout coil 36 and the magnetic core member 42 thereof, and provide for conducting the magnetic flux into the side plates. Suitable insulating means may be provided adjacent the gap 32 to prevent flashover or other damage from an arc, such as the insulating housing 43 for the coil, and the insulating side plates 45 which may comprise angle sections having a vertical portion shielding the plates 39 from the arc and horizontal portions extending along the lower edges of the side beams.

With a view to securing a further concentration of the magnetic flux in the arc gap 32 the side plates 39 may be so positioned that the portions adjacent the arc gap are closer to each other than are those elsewhere. For example, the side plates 39 may be either bodily convergent towards the wider ends, or the lower portions thereof adjacent the lower ends of the arc horns 33 may be deformed inwardly as shown in Figures 1 and 6, to provide an air gap of lower reluctance at the point of initiation of the arc. The same effect may be secured by positioning the plates 39 on the outside of the side members and having inturned portions on the inside thereof only at the arc gap.

In order to provide for rapidly extinguishing the arc, it is preferable that the runner member 16 be of such a length that the magnetic field produced by the arc blowout coil 36 and the side plates 39 be at its maximum value slightly prior to or at the instant the arc is drawn across the arc gap 32. A permanent magnet might be used in place of the coil 36 to produce the necessary flux, in which case the field would definitely be established prior to the arc. Since the speed of the vehicles on which the current collectors are mounted varies over a relatively wide range, the length of the runner member may likewise vary over a relatively wide range. We have found that with an arc blowout coil of approximately 30 turns of .047×.625 copper strap wound edgewise on a core of about ⅝" diameter and side plates of $\frac{3}{16}$" sheet steel such as shown, and trolley speeds of one and one-half to three miles an hour, at which the worst arcing conditions seem to occur, the length of the runner member 16 should be on the order of from one to approximately five inches. Below approximately one inch the results are not satisfactory, and at higher speeds, this range of lengths appears to be quite satisfactory.

With a section insulator of the type hereinbefore described and a current collector traveling at approximately two and one-half miles per hour, and drawing on the order of 300 amperes, extinction of the arc has been affected in less than one cycle of a 60 cycle timing wave as shown by the curves in Figure 7 which are reproductions of actual oscillograph curves. In this figure, (*a*) represents the voltage curve while (*b*) represents the current curve. From the 60 cycle timing wave shown below these curves, it will be observed that less than one cycle elapsed from the instant that the arc was drawn, as indicated by the drop in the voltage curve at the point (*c*) until the arc current reached the zero value at the point (*d*). This performance greatly exceeds that possible with section insulators of the usual type wherein the arc is either interrupted by merely drawing it out or by forcing it downwardly away from insulating runner member by means of coils or otherwise.

From the above description and accompanying drawings it will be apparent that we have provided, in a simple and effective manner, for rapidly extinguishing the arc drawn by a current collector as it traverses a section insulator. A minimum of arcing time results since the magnetic field is at its maximum value at the instant the arc is drawn and, hence, operates most efficiently to extinguish the arc. The operating of a section insulator embodying the principles of our invention is exceedingly long, since the arc does not contact either of the insulating members which form the strain transmitting members of the insulator. The arc horns, which are the only parts subjected to any burning effect by the arc, are readily detachable and may be easily removed without removing the insulator

from the overhead. By using a magnetic field structure such as described, arcs are quickly forced upwardly and are stretched out and broken before they can do any appreciable burning of even the arc horns.

Since certain changes may be made in the above description and different embodiments of the invention may be made without departing from the spirit or scope thereof, it is intended that all the matter contained in the above description and shown in the accompanying drawings shall be considered as illustrative and not in a limiting sense.

We claim as our invention:

1. A trolley conductor section insulator comprising a pair of end members connected by spaced apart insulating members, a metallic-runner member positioned between the insulating members having a gap therein, means for providing a undirectional magnetic field transversely of the gap prior to and during the passage of a current collector to force an arc in the gap upwardly, and metallic arc horns positioned in upward diverging arcing relation between the insulating members on opposite sides of the gap.

2. A section insulator comprising, a pair of end members, spaced apart members of insulating material maintaining the end members in spaced relation, a pair of metallic runner members positioned in end to end spacial relation with each other and with one of the end members to provide gaps therebetween, and means including a coil connected in bridging relation between said one end member and the adjacent runner member to provide a substantially uniform unidirectional magnetic field in a region extending vertically between the insulating members from the gap between the runner members for forcing an arc therebetween upwardly.

3. A trolley conductor section insulator comprising, a pair of end members for connection to adjacent ends of a trolley conductor, a pair of elongated strain members of insulating material positioned in spaced relation on opposite sides of the end members and secured thereto for maintaining the end members in spaced relation, means including metallic runner means positioned between and supported by the insulating members for guiding a current collector, said means being arranged to provide a pair of spaced apart gaps, means including a coil connected across the gap nearer the leading end for producing a substantially uniform unidirectional magnetic field transversely of the other gap in such a direction as to force an arc in the other gap upwardly, and a pair of upwardly divergent metallic arc horns secured to the runner member in arcing relation on opposite sides of the other gap.

4. A section insulator comprising, spaced apart metallic end members, spaced apart side members of insulating material maintaining the end members in spaced relation, a metallic runner member positioned between and supported by the side members in spaced relation to one of the end members and having a transverse gap at a predetermined distance from the one end member, and electromagnetic means for producing a substantially uniform concentration of magnetic flux lines in the region of and above the gap in one direction so as to force an arc in the gap upwardly including a winding connected between the one end member and an adjacent portion of the runner member.

5. A trolley section insulator comprising, a plurality of metallic runner portions positioned

in spaced end to end relation so as to provide a pair of gaps separated by a predetermined distance, and means providing a concentration of magnetic flux at and extending upwardly of one of the gaps for moving an arc upwardly in said one of the gaps, said means including a coil connected across the other of the gaps and said gaps being so spaced relative to each other that the magnetic field across the one gap is established before a current collector traversing the insulator reaches said one gap.

6. A trolley section insulator comprising, metallic end members maintained in spaced relation by insulating members positioned on opposite sides of the members and connected thereto, a metallic runner member positioned between and supported by the insulating members in spaced relation to one of the end members, an additional runner member positioned between and supported by the insulating members in predetermined spaced relation to provide a gap between it and such first-mentioned runner member having a pair of divergent arc horns, a pair of elongated plates of magnetic material tapering in width positioned on either side of the runner members and extending only from the said one runner member to the gap, with the wider portion opposite the gap, and a coil positioned between the narrower portion connected between the one end member and the first-mentioned runner member.

7. A section insulator comprising, spaced metallic end members, a metallic runner member positioned in spaced end to end relation with one of the end members and having a transverse arc gap therein, tapered side plates of magnetic material positioned on opposite sides of the gap having the portion of greater width adjacent the gap and in closer proximity to provide a lower reluctance air path at the gap, and a coil connected between said one end member and the runner member having a core of magnetic material connected between the side plates adjacent a portion of reduced width.

8. A trolley conductor section insulator comprising, spaced metallic end members for connection to adjacent ends of a trolley conductor, side members of insulating material positioned on opposite sides of the end members and extending therebetween to maintain the end members in predetermind spaced relation, a pair of runner members positioned between the side members in spaced end to end relation with each other and one of the end members to provide a first gap adjacent said end member and a second gap between the runner members, a pair of upwardly divergent arc horns positioned one on each side of the second gap, a pair of tapered plates of magnetic material positioned between the side members with the under portion convergent adjacent the second gap, and a winding connected across the first gap having a magnetic core connected between the plates of magnetic material at the end remote from the second gap.

9. A trolley section insulator comprising, spaced apart end members connected by elongated spaced side members of insulating material, longitudinally spaced metallic runner members positioned between and supported by the side members to provide a first gap near one end and a second gap adjacent thereto, a pair of upwardly divergent arc horns having projecting ears for detachably securing them to the runner members at the second gap to provide an upwardly divergent path for an arc drawn between the members by a current collector traversing the insulator,

and means providing a concentrated transverse magnetic field in one direction only at the second gap whenever a current collector traverses the first gap.

10. A trolley conductor section insulator comprising, a pair of metallic end members for connection to adjacent portions of a trolley conductor, elongated side members of insulating material spaced on opposite sides of the end members and connected thereto to maintain them in predetermined spaced relation, metallic runner members positioned between and supported by the side members in spaced relation to one of the end members and to each other to provide air gaps therebetween, tapered plates of magnetic material having the wider ends convergent adjacent the gap between the runner members, and a coil connected across the gap between said one end member and the runner member adjacent thereto and having a core of magnetic material connecting the plates of magnetic material adjacent the narrow ends.

11. A section insulator comprising, a pair of spaced apart end members having runner portions on the lower sides for guiding a current collector, elongated side beams of insulating material positioned on opposite sides of the end members and connecting them together, a pair of metallic runner members positioned between the side beams having runner portions on the lower sides in alinement with the runner portions on the end members, said runner members being spaced from each other and from the end members, arc horns detachably connected to the runner members at the adjacent ends, a plate of magnetic material positioned on each side of the runner members, a coil connected between one of the end members and the adjacent runner member and arranged to produce a transverse flux in the gap between the runner members for forcing any arc drawn therebetween upwards, and insulating means positioned between the runner members and the plates of magnetic material.

12. A trolley conductor section insulator comprising, a pair of end members maintained in spaced and insulated relation by spaced side beams of insulating material, a metallic runner member of predetermined length supported between the side beams in spaced relation to one of the end members, and an additional metallic runner member supported between the side beams in spaced end to end relation to said first-mentioned runner member to provide an arc gap therebetween, a pair of upwardly divergent arc horns secured to the runner members at the gap, a pair

of tapered plates of magnetic material positioned on opposite sides of the runner members and having the wide end adjacent the gap between the runner members, said plates being so arranged that the distance therebetween is less adjacent said gap than elsewhere so as to provide a relatively low reluctance flux path across the gap, insulating means interposed between the magnetic plates and the runner members, and a coil positioned above one of the runner members connected between an end member and the adjacent runner member and having a core member of magnetic material connecting the plates of magnetic material adjacent the narrow end.

13. An insulating device for sectionalizing the conductor of a trolley system comprising, an elongated bar consisting of a pair of spaced members of insulating material and means to maintain said spacing, means at each end of the bar to receive and hold adjacent ends of the trolley conductor, spaced contact means along one side of the bar to be engaged by a passing current collector whereby the collector may draw current therefrom, upwardly diverging arcing horns from the adjacent ends of each contact means and positioned between the said spaced members to direct upwardly any arc formed between the said adjacent ends of the contact means, and magnetizable means to set up a magnetic field transversely of the said adjacent ends of the contact means to force the arc upward and means to effect magnetization of the magnetizable means before the current collector reaches the arc gap.

14. A sectionalizing device for the conductor of a trolley system comprising, a pair of end members each having means to receive and hold the end of a trolley conductor, tension means of insulating material secured to the end members to hold them in spaced and insulating relation, a plurality of spaced contact members extending between the end members, one contact member forming an arcing gap with an adjacent contact member and an insulating air gap with one of the end members, magnetizable means including an energizing coil and inwardly projecting poles so positioned adjacent the arcing gap as to set up a magnetic flux between poles and across the arc gap to force upwardly the arcs formed at the arcing gap, the coil being so connected in shunt across the insulating air gap that it (the coil) will be energized when the current collector of a passing vehicle is in contact with the said one contact member and drawing current.

RAYMOND P. HANNA.
NORMAN H. WILLBY.