June 22, 1937. H. J. CRAWFORD 2,084,523

ABRASION RESISTANT GROUNDING DEVICE

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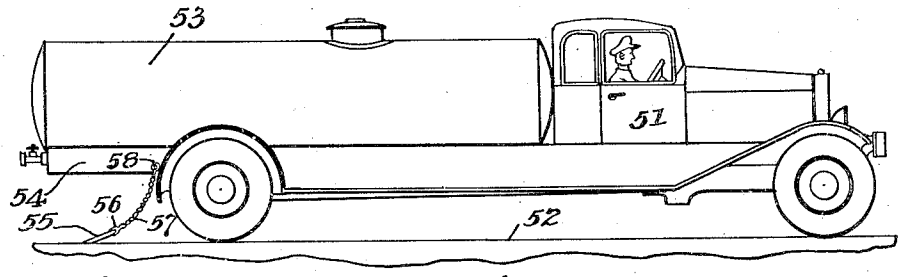


Fig. 8.

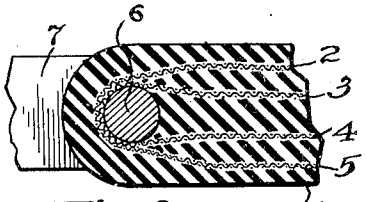


Fig. 3.

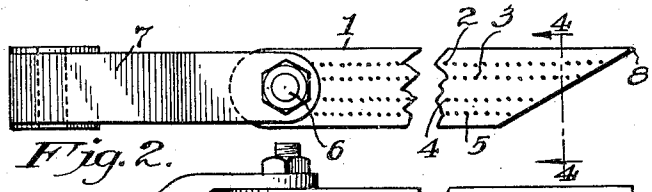


Fig. 2.

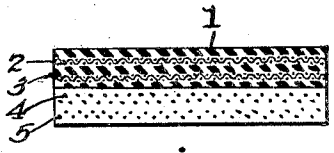


Fig. 4.

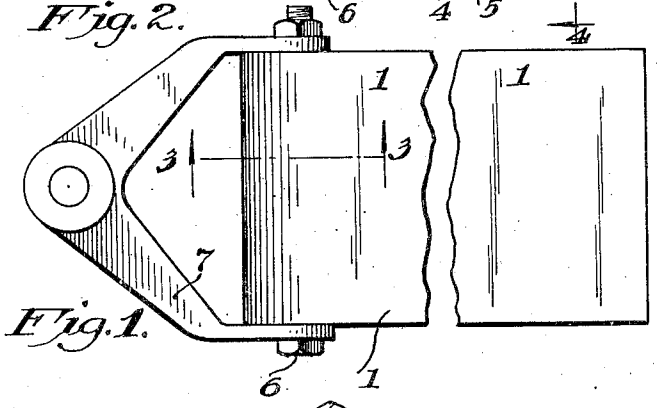


Fig. 1.

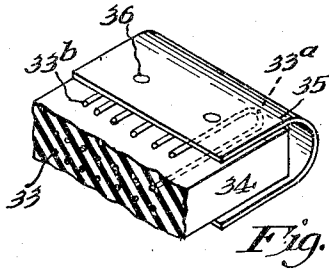


Fig. 6.

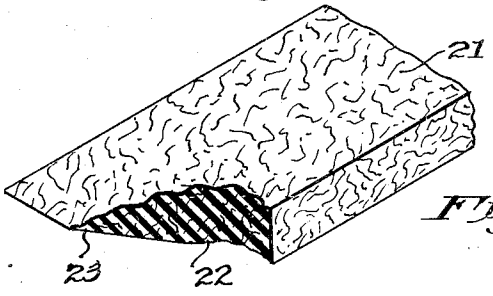


Fig. 5.

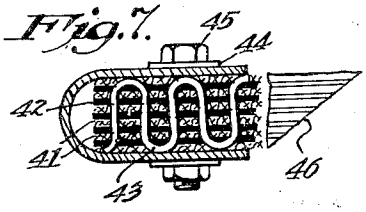


Fig. 7.

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ABRASION RESISTANT GROUNDING DEVICE

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8 Claims. (Cl. 175—264)

This invention relates to an abrasion resistant grounding device and pertains particularly to a device which may be secured to a moving vehicle or the like in position to engage the ground, i. e., the surface over which said vehicle is travelling, for the purpose of dissipating accumulated static charges from said vehicle to ground in the absence of pyrophoric sparks or the like. The expression "pyrophoric sparks" may be understood to mean sparks comparable to those produced by frictional engagement of an abrasive material with a pyrophoric material such as a ferrous metal.

It is common practice to provide a metallic grounding device for vehicles which are carrying volatile explosive or combustible materials, such as gasoline or the like, so that any accumulated static charges which are produced in such vehicles are substantially continuously dissipated to ground. In general, such grounding devices have consisted of a length of metallic chain or cable provided with a hardened steel contact member in position to drag upon the ground and effectively dissipate the aforementioned charges, and such a device will cause the formation of a large quantity of pyrophoric sparks by the intermittent frictional engagement of the hardened steel contact member with the ground, and are found to be very rapidly abraded by such contact, necessitating frequent replacement of the contact member. Attempts have been made to coat the contact member with a "hard-surfacing" material such as "Stellite", but it has been found that abrasion has not been sufficiently diminished by such procedure to a point which would justify the added expense thereof. In order to diminish or substantially eliminate the production of pyrophoric sparks, hard bronze contact members have been substituted for the aforementioned hardened steel contact member in some cases, but it has been found that the abrasion resistance of such a material is not high enough to justify the use thereof. Furthermore, all of the above-mentioned types of grounding devices make an objectionable amount of noise in their incessant impact with a hard-surfaced road.

According to the present invention, I provide a contact element, which may be electrically secured to the frame or body of a vehicle in any suitable manner as through the agency of an electrically conductive chain or cable, in which a body element or matrix of a non-metallic material of good abrasion resistant characteristics is provided with material of good electrical conducting characteristics incorporated therein, whereby an adequate electrical conductivity is obtained through the length of said contact element along with the very desirable resistance to abrasion.

In its preferred embodiment, the device of the present invention is flexible in nature, whereby contact thereof with an abrading surface will be free of a pronounced shock, thereby diminishing the abrasive effect of such surface thereon, it being appreciated that such a device will in general be somewhat elongated in shape and attached to the vehicle body at one end, the other end being allowed to freely engage the abrading surface.

One of the principal objects of the invention is to provide an abrasion resistant grounding device having electrically conductive characteristics. A further object of the invention is to provide a flexible abrasion resistant grounding device having electrically conductive characteristics, and adapted to yield upon forceful contact with a solid body in the absence of pronounced shock and noise.

A further object of the invention is to provide a device of the character described in which one or more electrically conductive and non-pyrophoric elements are provided in a matrix of abrasion resistant material.

The device of the present invention, in its simplest embodiment, may comprise a plurality of electrically conductive elements, such as strips or particles, of non-pyrophoric material embedded in a matrix of rubber or other flexible, and preferably resilient, non-metallic material of high abrasion resistant characteristics, but normally of very low electrical conductivity, the conductive elements being preferably brought together at one end of the device in position to provide electrical contact with one another at the position of or through the agency of a suitable clamping device through which the device may be electrically and structurally secured to a vehicle body. The electrically conductive elements of the device may comprise strips or wires of a preferably non-pyrophoric metal, such as brass, copper, or bronze, preferably electrically inter-connected at one end of the device to facilitate electrical and structural attachment of such device to a vehicle body, but it will be appreciated that non-metallic electrically conductive elements such as graphite-impregnated fabric may be equivalently employed. Furthermore, the abrasion resistant matrix may consist of a fabric material, if desired, or may comprise a rubber-impregnated fabric, within the contemplation of the present inven-

tion. Alternatively, the electrically conductive characteristics desired in the device may be obtained by incorporating an electrically conductive material in a rubber matrix in intimate dispersion, as by "loading" rubber with from 5 to 30% of flake graphite, metallic foil, metallic fibers, or the like, or such an electrically conductive matrix may be provided with additional conductive elements such as metallic strips or the like as above described.

Certain exemplary embodiments of the invention are illustrated in the accompanying figures of the drawing and referring thereto:

Fig. 1 is a plan view of an embodiment of my invention which utilizes electrically conductive screen or wire cloth elements embedded in a rubber matrix;

Fig. 2 is a side elevation thereof;

Fig. 3 is an enlarged partly broken away sectional detail thereof taken on line **3—3** in Fig. 1, illustrating a method of connecting a conductive element to a connecting means;

Fig. 4 is a sectional view thereof taken on line **4—4** in Fig. 2;

Fig. 5 is a partly broken away perspective view of an alternative embodiment of my invention which utilizes metal foil or the like to provide the desired electrically conductive characteristics to the device;

Fig. 6 is a partly broken away perspective view of an alternative embodiment of the invention which utilizes conductive cords or the like in the relation of conductive elements, provided with a modified form of attaching means;

Fig. 7 is a view corresponding to Fig. 3, showing a further embodiment of the invention; and

Fig. 8 is a side elevation of a vehicle showing a device of the present invention in use.

Further objects of the invention will be specifically set forth in the following description or will be apparent therefrom.

Referring to Figs. 1 to 4, the abrasion resistant grounding device is shown as comprising a resilient matrix **1** of rubber or the like, preferably vulcanized rubber, in which a plurality of layers of electrically conductive material such as screen fabric of copper or other non-pyrophoric metal are embedded as at **2**, **3**, **4**, and **5**. The screens are shown in intimate contact at one end of the device with each other and with a suitable connecting means, such as the bolt **6**, which is in turn connected to a suitable clevis or clamp means **7** which may be connected through a suitable electrical connector, such as a chain or cable, not shown, to the object which is to be grounded. It will be appreciated that the matrix **1** may either be molded in a single piece with the conductive material incorporated therein, or it may be formed of sheets with the screens placed between each sheet and then vulcanized. In either case it is preferable that the mesh of the screen be sufficiently wide to allow the matrix to interbond therethrough except in the event that the matrix completely surrounds such conductive elements. Furthermore, perforated metal plates may be substituted for the screens or plates without perforation if the matrix completely surrounds the plates.

In Fig. 5, I have illustrated an alternative embodiment of my invention in which a suitable block **21** may be molded from rubber in which a suitable quantity of electrically conductive particles have been dispersed, as at **22**. Said electrically conductive particles, which are thus embedded in the block **21**, may comprise metal foil, metal turnings, metallic fibers, graphite particles or the like, preferably of a non-pyrophoric character. It will be appreciated that in this embodiment of my invention suitable electrical connection may be made to the block **21** by molding a suitable threaded rod, similar to the rod **6** shown in Fig. 1, into the matrix at a convenient point, or other suitable means may be provided for electrical connection, as will be subsequenty brought out.

Fig. 6 shows an alternative type of grounding device which may be formed by embedding strips of conductive material into a suitable rubber matrix. A suitable matrix is shown at **34** in which conductive strips may be embedded as at **33**. The strips **33** may be of wire, fabric cords impregnated with graphite, braided wire and fabric material, or other conductive material. The conductive elements may be connected together in any suitable manner as by twisting, soldering, clamping, or by other suitable means according to the particular material used for the conductive element so that electrical connection may be made between the object to be grounded and the conductive element.

As an example of an alternative type of clamping means, the form of contact element shown in Fig. 6 is shown with conductive elements of such length as to extend beyond one end of the member or matrix **34**, and folded or bent back over the matrix, a suitable U plate or other suitable clamping or connecting means being secured to the matrix and to the conductive elements for the purpose of securing the grounding device to the object which is to be grounded and for obtaining a desirable electrical connection therebetween.

For purposes of simplification only one of the conductive elements **33**, designated as **33*a***, is shown in dotted lines extending through the back of the matrix **34**, although it will be appreciated that preferably all of the conductive elements may be bent over in the above-described manner, the ends of which are shown terminated at **33*b***. A suitable clamp or U plate **35** may then be placed over the matrix **34** and the bent back strips **33** and clamped firmly into position by rivets **36** or the like. It will be appreciated that the clamp **35** may also be employed with the embodiment of my invention delineated in Fig. 5. It will further be comprehended that the matrices illustrated in Figs. 1 to 4 or in Fig. 6 may be loaded with a suitable proportion, such as from 5 to 30%, of flake graphite, metal filings, metal foil or other conductive material, or with combinations thereof, in order to enhance the conductive properties of the grounding device. The exact limits of loading material may be determined to some extent by the desired abrasion resistance of the matrix in combination with the desired electrical characteristics thereof and although I find the limits of from 5 to 30% flake graphite or other material advantageous, I do not choose to be limited by these percentages.

Referring to Fig. 7, an alternative form of my invention is shown as comprising a plurality of fabric sheets **41** each coated with a layer of electrically conducting material such as graphite or the like as at **42**. The fabric may be a wire cloth fabric consisting of interwoven wire and fabric or other conducting fabric or it may be a substantially non-conducting fabric without departing from the spirit of this invention. When using a conducting fabric the conducting coating **42**

may be dispensed with if such procedure is considered desirable. Any convenient means may be employed for electrically inter-connecting the respective sheets 41 and the surfaces 42; however, I find it preferable to stitch or lace the respective sheets together with a conducting thread as at 43. Said thread may be of wire, a mixture of wire and fabric, a metal ribbon, or other thread having electrical conducting properties. I also find it preferable to employ a clamp 44, which may be similar to the clamp 35 in Fig. 6, for the purpose of providing mechanical and electrical connection between the vehicle and the grounding device. The U plate 44 may be held firmly in contact with the sheets 41 and the threads 43 by any suitable means, for example, by bolts 45, or by rivets or the like. The shape of the fabric sheets and the block formed therefrom may be comparable to the above-described embodiments or any other convenient form or shape as will be subsequently described. It will be appreciated that the stitching with the conducting thread need not extend beyond the ends of the clamp 44 and that the sheets may be stitched or otherwise intersecured with non-conducting material for the remaining portion of the device, in any suitable manner.

Referring to Fig. 3, a vehicle, such as, for example, a gasoline tank-truck, is indicated generally at 51 operating on a road or other ground surface 52. The vehicle further comprises a tank 53 and a frame or body structure 54 to which may be attached a grounding device of this invention as indicated at 55. Said device may be attached to the truck 51 in any suitable manner, such as, for example, by a clamp 56, which may be similar to the clamp 7 of Fig. 1 or the clamp 35 of Fig. 6, and by a chain or cable or other electrical connector 57 which may be connected at one end to the clamp 56 and at the other end to the frame member 54 by any suitable means, as at 58. It will be appreciated that the connector 57 may be formed integrally with the device 55 if so desired and that said connector may also be attached to the vehicle 53 at points other than the frame member 54.

The grounding devices produced according to my invention may be of any desired shape; however, I find it advantageous to make them, for example, about 6 to 12 inches long, one inch thick, and from 2 to 6 inches wide. As previously brought out, connection is usually made to one end of the grounding device, and since the device is usually dragged behind the vehicle on a chain, cable, wire or other form of connector, the device will tend to make connection with the surface of the road or ground, at one end. It is for this reason that I prefer to form the device with a beveled end as shown at 6 in Figs. 1 and 2, at 23 in Fig. 5, and at 46 in Fig. 7, although this beveled edge may be omitted, if desired, from some embodiments, since the device will form a beveled edge after being used for a time.

The greatest wear in any sort of grounding device which is dragged behind a vehicle usually comes from the impact of the device against the road or other objects and it will also be noted that these grounding devices do not stay in contact with the ground but tend to bounce along the ground striking it intermittently. It is this bouncing phenomenon which greatly increases the impact abrasion of these grounding devices and also tends to produce pyrophoric sparks and make a relatively large amount of objectionable noise. It is one of the objects of this invention to provide resilient grounding device comprising a plurality of non-pyrophoric contact members in a resilient matrix so that the abrasion of the contact members will be greatly retarded due to the fact that the impacts occasioned by such a grounding device will be materially absorbed by the matrix, and a relatively small amount of noise is produced.

It is appreciated that it is not always possible for the highly conductive elements such as the screens 2, 3, 4, and 5, the foil strips 22, and the conductive strips 32 and 33 to make direct connection with the ground each time the grounding device strikes the ground, however, these highly conductive elements may strike the ground in many instances, and in those instances which they do not strike the ground, there will be a comparatively short path to ground through the matrix. It is further comprehended that the resistivity of the matrix may be of fairly high order even when it is loaded to a maximum. However, since the path through the matrix from a highly conductive element to ground will normally be comparatively short, the actual resistance of the path will be comparatively low. Motor vehicles, tank trucks, airplanes and other vehicles, although of comparatively large dimensions, have relatively small capacities in terms of microfarads and even though they may be charged to relatively high voltages with respect to ground the actual quantity of electricity represented is of an extremely low order and may be dissipated to ground in a relatively short time even though the resistance of the current path is relatively high as compared to a direct metallic contact.

I claim:

1. A grounding device for dissipating static charges from a moving vehicle, which comprises: an elongated flexible body element formed of non-metallic material of high abrasion resistant characteristics and provided with electrically conductive material incorporated therein, said electrically conductive material being so placed and being present in such amount in said element as to provide for electrical conduction therethrough in the direction of the length of said element; and electrically conducting attachment means at one end of said element for electrically and structurally securing the same to a vehicle, said body element being mounted on such vehicle through the agency of said attachment means in such manner that the other end of said body element will engage the ground surface over which such vehicle is moving.

2. The device set forth in claim 1, said element comprising a matrix of rubber, and said electrically conductive material comprising a plurality of elongated metallic members embedded in said rubber and extending longitudinally through said element.

3. The device set forth in claim 1, said element comprising a matrix of rubber, and said electrically conductive material comprising a plurality of elongated metallic members embedded in said rubber and extending longitudinally through said body element and electrically interconnected at said one end of said element.

4. A grounding device for dissipating static charges from a moving vehicle, which comprises: an elongated flexible body element formed of non-metallic material of high abrasion resistant characteristics; a plurality of electrically conductive members disposed within said element and

extending longitudinally therethrough from adadjacent one end to and through the other end thereof, said conductive members being electrically interconnected at said one end; and electrically conductive attachment means at said one end in electrical contact with said members, for electrically and structurally securing said element to a vehicle, said body element being secured to such vehicle through the agency of said attachment means in position to engage the ground surface over which such a vehicle is moving solely at the other end of said body element.

5. The device set forth in claim 4, said flexible element being formed of vulcanized rubber loaded with from 5 to 30% of graphite.

6. The device set forth in claim 4, said flexible element comprising a laminated fabric structure, and said conductor members being disposed between adjacent layers of fabric.

7. The device set forth in claim 4, said flexible element comprising a laminated fabric structure and said conductive members comprising conductive layers of graphite disposed between adjacent layers of fabric.

8. A non-pyrophoric grounding device for dissipating static charges from a moving vehicle, which comprises: an elongated flexible body element formed of a resilient non-metallic material of high abrasion-resistant characteristics; a plurality of electrically conductive members formed of a non-pyrophoric metal extending longitudinally within said element from adjacent one end thereof to and through the other end thereof, said conductive members being electrically interconnected at said one end; and electrically conductive attachment means at said one end of said element in electrical contact with said conductive members, for electrically and structurally securing said element to a vehicle, said body element being secured to such vehicle through the agency of said attachment in position to engage the ground surface over which such a vehicle is moving solely at the other end of said body element.

HARRY J. CRAWFORD.