July 7, 1964 H. L. RORDEN 3,139,948

METHOD AND APPARATUS FOR WORKING ENERGIZED CONDUCTORS

Filed April 25, 1961 3 Sheets-Sheet 1

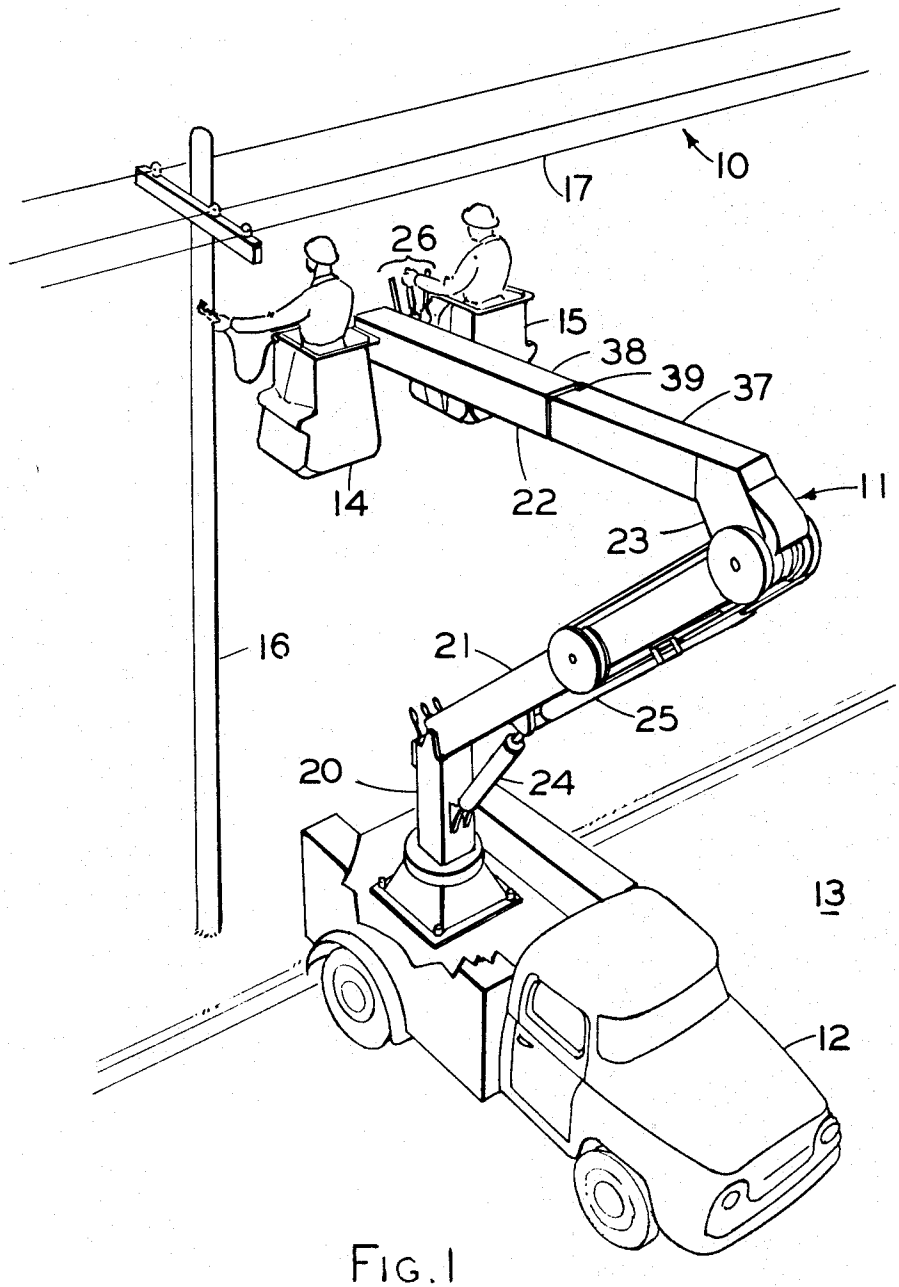


FIG. 1

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METHOD AND APPARATUS FOR WORKING ENERGIZED CONDUCTORS

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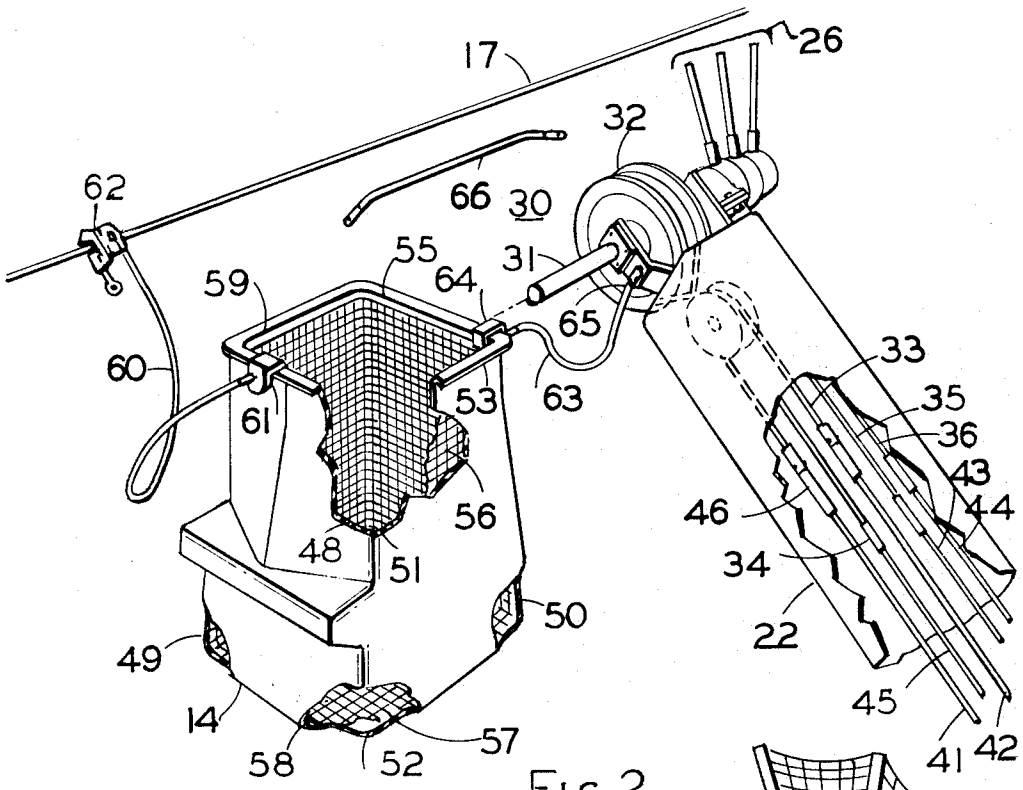


FIG. 2

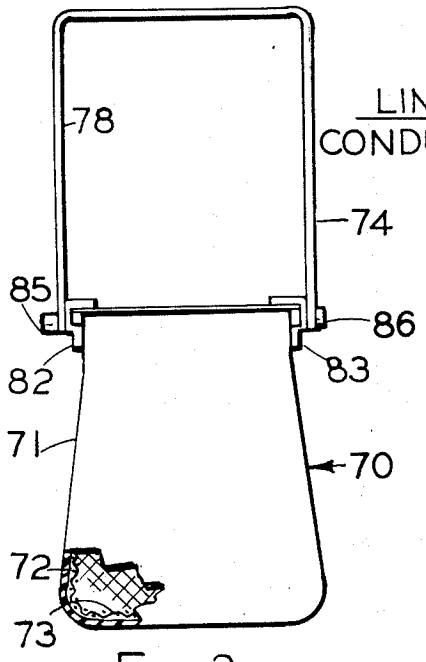


FIG. 3

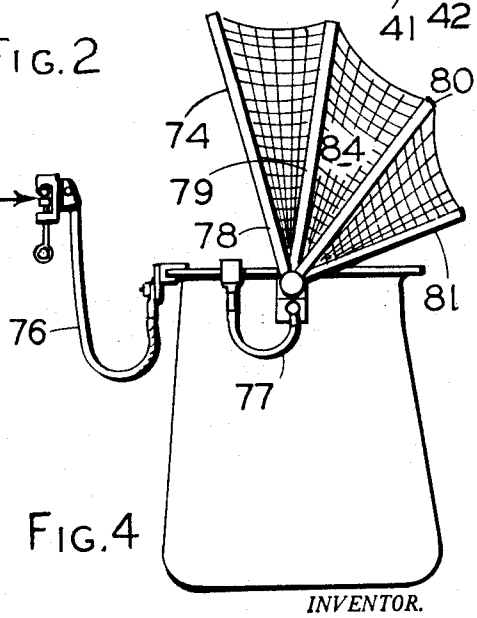


FIG. 4

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METHOD AND APPARATUS FOR WORKING ENERGIZED CONDUCTORS

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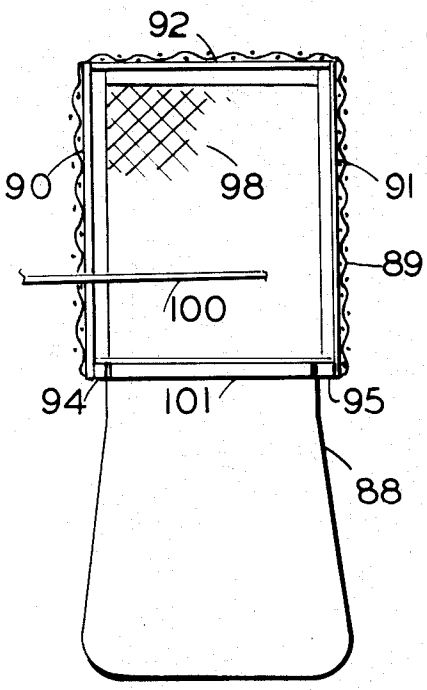


FIG. 5

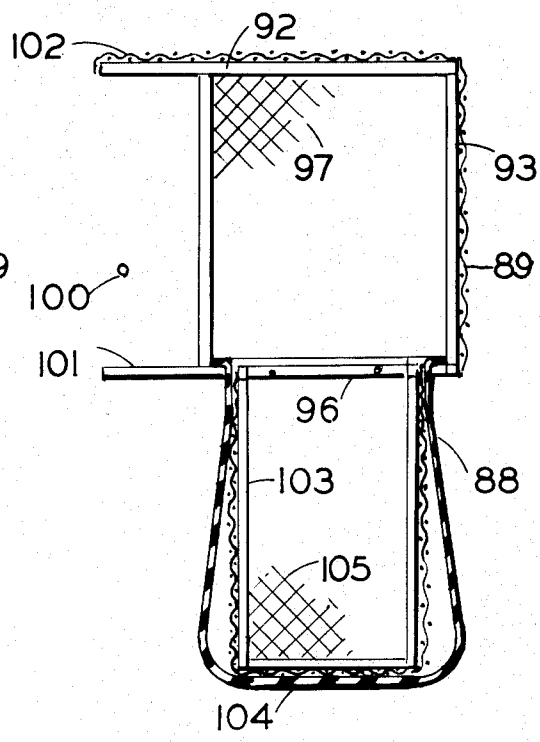


FIG. 6

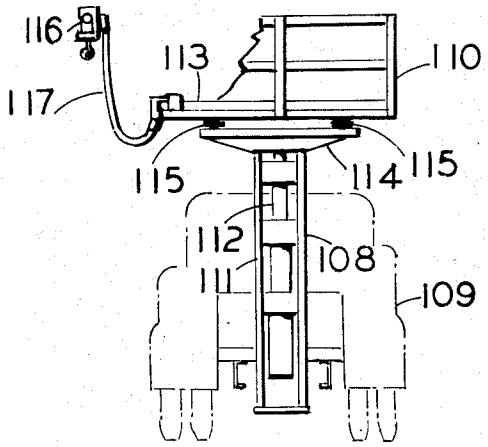


FIG. 7

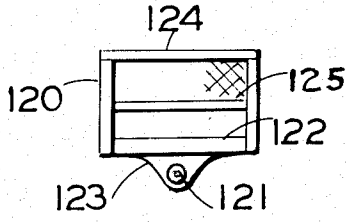


FIG. 8

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United States Patent Office 3,139,948 Patented July 7, 1964

3,139,948

METHOD AND APPARATUS FOR WORKING ENERGIZED CONDUCTORS

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Filed Apr. 25, 1961, Ser. No. 105,456
25 Claims. (Cl. 182—2)

This invention relates to the installation, maintenance and repair of electric line conductors and more generally to working electrically energized conductors, conductor apparatus, and the like.

A principal object of the invention is to provide a new and improved method of and means for working electrically energized conductors.

Another principal object of the invention is to provide for power line repair and maintenance, at high voltages, and under adverse conditions of wet weather and the like, while the line is electrically energized.

Still another object of the invention is to simplify and expedite the maintenance and repair of electric power lines and to reduce or eliminate the use of insulated tools.

Another object of the invention is to reduce the possibility of shock and other hazards incurred by workmen in servicing and repairing electrically energized power lines.

A general object of the invention is to reduce service outages in electric supply systems.

In the operation of electric power systems continuity of service is an important consideration and interruptions due to line outages are undesirable and expensive. Accordingly, it is advantageous to conduct maintenance and repair operations without system shutdown and various methods and techniques for energized line working have been developed, wherein the line conductors and conductor apparatus may be repaired or replaced without being disconnected from the associated energized circuits. One technique for energized line working is accomplished by means of live-line tools, so called, which facilitate manual manipulation of the conductors and related apparatus while the conductor is energized. However, because of the great amount of insulation required, such tools are cumbersome and unwieldy and even the simpler repair operations are difficult and time consuming. Again, many repair operations cannot readily be performed by the use of such tools and require that the circuits be deenergized.

The present invention is concerned with a new concept of line working in which the lineman is maintained at the same potential as the energized conductor while performing maintenance and repair operations upon the conductor or related conductor apparatus. In contrast with the practices of the prior art just described, in which the lineman is electrically separated from the energized conductor by the insulated tools, I have found that many advantages may be achieved by supporting a lineman adjacent the energized conductor in insulated relation to the earth and energized to the same electric potential as the conductor. This enables the lineman to make direct contact with the line conductor and permits manipulation of the conductor and conductor apparatus without use of insulating tools.

I have found that the invention is useful at all power line voltages but particularly at voltages above 25,000 volts. I provide a carrier which is insulated from the earth or ground or adjacent apparatus or equipment and has a conductive surface which is electrically contacted by the linemen. The conductive surface is connected to the line conductor apparatus or other energized equipment to be worked upon and after this connection is made, the linemen can contact the energized parts with bare hands or with conventional work gloves on their hands.

At the higher transmission voltages I have found it desirable to provide additional shielding in the form of a screen constituted by a conductive sheet member disposed

over and about the lineman. The shielding protects the linemen from the intense electric fields about the conductor, after the manner of a Faraday Cage.

The invention together with further objects features and advantages thereof, will be more fully understood by reference to the following detailed specification and claims taken in connection with the appended drawings, in which—

FIG. 1 illustrates the invention in connection with the use of an aerial lift for the repair or maintenance of an overhead line conductor;

FIG. 2 is an enlarged view of a portion of the apparatus of FIG. 1, particularly illustrating the apparatus of the invention;

FIGS. 3 and 4 illustrate shield apparatus useful in practicing the invention at very high voltages;

FIGS. 5 and 6 show another form of shield apparatus similar in purpose to that of FIGS. 3 and 4;

FIG. 7 illustrates the practice of the invention with a telescoping tower and platform; and

FIG. 8 illustrates the practice of the invention in another embodiment utilizing a working platform.

There is shown in FIG. 1 an overhead transmission line **10** together with an aerial lift **11** carried by a vehicle **12** for transport along a road or right of way **13** adjacent the transmission line. According to this embodiment, the practice of the invention involves the utilization of the aerial lift **11** in accomplishing maintenance, repair, construction or other work upon the transmission line **10**. The work may be accomplished while the conductors of the transmission line are maintained in an energized condition.

The aerial lift **11** functions as an elevating means for lifting a personnel carrier constituted by either one or both of two buckets **14** and **15** from a loading position adjacent the ground to an elevated or working position adjacent the top of the pole **16** or adjacent the conductor **17** of the transmission line **10**. The buckets **14** and **15** have a depth and cross sectional extent such that a lineman standing in the bucket has substantial freedom of movement from his waist upward and cannot readily move to an overbalanced position. Tools, repair parts and equipment and material are carried in the bucket with the lineman.

The aerial lift **11** comprises a pedestal **20**; a mechanical arm constituted by a lower boom **21**, pivotally supported at its lower end on the pedestal **20**; an upper boom **22**; a hinge connection or elbow joint **23** between the lower end of the boom **22** and the upper end of the boom **21**; a hydraulic cylinder **24** for elevating and lowering the boom **21** with respect to the pedestal **20** and the vehicle **12**; a hydraulic cylinder **25** for extending and retracting the boom **22** with respect to the boom **21**; and a drive apparatus (not shown) for turning the assemblage about a vertical axis through the pedestal **20**. Suitable control means are provided for the hydraulic cylinders and the drive apparatus and control levers **26** mounted on the boom **22** adjacent the buckets **14** and **15** are connected to the control means by means of cables extending through the booms. With this arrangement, the personnel carrier may be moved to the necessary working position under the control of the lineman in the personnel carrier.

The arrangement of the bucket **14** and the boom **22** and related apparatus is shown in detail in FIG. 2. Thus, a head **30** constituted by a shaft **31** and a drum **32** is carried at the outer end of the boom **22**. The buckets **14** and **15** are carried on the shaft **31** and are maintained in an upright position with respect to the ground, whatever the position of the boom **22**, by means of a leveling apparatus. Leveling is accomplished by a cable system, acting through a cable **33** which extends about and is secured to the drum **32**. The control levers **26** are

mounted upon the shaft 31 and are connected to control valves in the pedestal 20 by means of a cable system in which cables for each of the levers, i.e., the cables 34, 35 and 36, extend through the interior of the boom 22.

According to the invention it is required that the buckets 14 and 15 be insulated from the vehicle 12 and from ground. This is accomplished in the apparatus of FIGS. 1 and 2 by constructing the boom 22 of structural insulating material along at least a portion of its length and by incorporating insulating spacers in the cables of the leveling and control systems. Thus, the boom 22 is formed in two parts with a metal inner part 37 secured to the elbow joint 23 and an outer part 38 of structural insulating material secured to the part 37 along a joint 39. The parts 37 and 38 comprise hollow rectangular members having a beam strength sufficient to accommodate the weight of the head 30, the buckets 14 and 15, and having the requisite load carrying capability. The part 38 may be made from a structural insulating material such as glass fiber reinforced resin (also referred to as fiberglass) according to techniques known in the art. Alternately, the boom 22 may be constructed of structural insulating material along its entire length or with metal sections at each end and an interposed section of insulating material.

The cable 33 and the cables 34, 35 and 36 are connected to the associated cables of the leveling and control cable systems in the section 37 of the boom 22 by means of spacers 41, 42, 43, 44 and 45 constituted by rods of structural insulating material. The spacers 41 to 45 extend along the length of the section 38 and into the section 37 and are connected to the cable ends within the two sections by means of connectors such as the connector 46. The spacers 41 to 45 transmit the cable tension between the operating members of the apparatus while effectively maintaining the electrical separation of the head 30 from the section 37 with the insulating section 38 of the boom proper.

Control systems utilizing hydraulic or other control circuits may utilize suitable insulating means, conduits, and the like for electrically separating apparatus at the head of the boom 22 from those parts of the apparatus in the boom 21 and in the pedestal 20. The electric insulating strength of the insulating section 38 and of the spacers 41 to 45 should be substantially in excess of the line to ground voltage of the transmission line 10. Insulating strengths of in the order of 500,000 volts or more may be achieved in practical structures.

The construction and arrangement of the buckets 14 and 15 will be evident from the illustration of the bucket 14 in FIG. 2. As therein shown, the bucket 14 has a generally rectangular disposition constituted by four sides 48, 49, 50 and 51 comprising the walls of the bucket and a bottom 52 comprising the floor of the bucket. The bucket is suitably reinforced by means of a ledge 53 which extends peripherally about the upper extremity of the walls and by means (not shown) on the inner wall 50 for supporting the bucket on the shaft 31.

In accordance with the invention, an electrically conductive liner 55, is arranged over the interior surface of the bucket 14 for shielding and energizing the body of the workman as hereinafter described. The liner 55 comprises a screen 56 which extends along the interior surface of the sides 48, 49, 50 and 51, and a screen 57 which extends over the interior surface of the bottom 42 of the bucket. The screens 56 and 57 are constituted, in the embodiment of FIG. 2, by two sheets of conductive wire mesh which are joined and connected along the bottom corner of the bucket by the wire 58. The wire mesh of the screen 56 is held, along its upper extremity, against the walls of the bucket by means of a metal member 59 which is fastened to the walls and constitutes an electrical terminal for the liner.

The liner 55 may be manufactured in one or more parts of wire mesh or other conductive sheet material. Again, the screens 56 and 57 may be constituted by means such as a coating of electrically conductive material applied directly upon the interior surface of the bucket. High electrical conductivity is not essential and durability is an important design consideration.

A connector 60 is secured to the ledge 53 of the bucket 14 by means of a clamp 61. The clamp 61 engages the terminal member 59 and provides an electrical connection between the cable of the connector 60 and the liner 55. A clamp 62 at the remaining end of the connector 60 normally disconnected from the line conductor 17 is arranged to be secured to the line conductor 17 after the workman has established his contact with the liner 55 and may be constructed for manipulation by hot line tools. A connector 63 having clamps 64 and 65, secured to the ledge 53 and terminal member 59 and to the head 30 of the boom 22 respectively, is provided to establish the voltage level of the head 30 and prevent the possibility of potential differences which might cause shock to the linemen. A connector 66 is provided for connecting the liner and the terminal of the bucket 15 and the liner and terminal of the bucket 14, although a separate line connector may be utilized with the bucket 15.

In the apparatus shown in FIGS. 1 and 2, the buckets 14 and 15 are constructed of structural insulating material, such as glass fiber reinforced resin, in order to provide an insulating barrier about the exterior of the liner 55. This has the advantage of preventing accidental short circuits between two line conductors which might otherwise occur while positioning the lift. The buckets may, within the spirit of the invention, be constructed of metal, such as aluminum, so that the liner 55 would not be required.

In the practice of the invention, the screen 57 performs two functions. First, the screen 57, with the line conductor 17 and the connector 60, functions as an energizing means for maintaining the lineman at the potential of the line conductor. An electrical connection between the body of the lineman and the screen member 57 is required for this purpose and is accomplished conveniently by shoes having electrically conductive soles. Other means may be utilized for providing an electrical connection between the body of the lineman and the line conductor, such as by contact with the liner 55 through stockings, gloves or other items of clothing embodying conductive materials, or directly, by the use of conductive bands encircling the arm or leg and appropriate connecting wires. It is important, of course, that no difference of potential be impressed across different parts of the body.

The second function of the screen 57 is to shield the body of the lineman with respect to earth, particularly at the intermediate and higher voltages. Thus, in the absence of the screens 56 and 57, and with the lineman in conductive contact with the line conductor 17, the electric field would extend from all parts of the surface of the body of the lineman to the earth (as ground) and to the other energized conductors of the line. However, because of the shielding effect of the screen, most of the field extends from the conductive surface of the screen and does not affect the body of the lineman.

At the lower line voltages, that is at line voltages of less than about 25,000 volts, the invention may be practiced by using only the screen 57 on the bottom of the bucket. The screen 57 is connected directly to the terminal 59, or the clamp 61, by means of a wire or other conductor. This arrangement represents a simplified embodiment of the invention however, and the arrangement of FIG. 2 is conveniently utilized at such lower voltages.

At line voltages in excess of about 25,000 volts, there is, in the absence of the screen 56, significant charging current between the body of the lineman and the earth. However, the screen 56 functions as a shield for the lower part of the body and prevents body effects during working operations upon the line conductor.

At line voltages in excess of 138,000 volts I have found that, in the embodiment of FIG. 2, the electric field on the upper half of the body produces a charging current sufficient to produce discomfort and may result in corona discharge from the fingers and other extremities of the body. For work at these voltages, I provide the arrangements of FIGS. 3 to 6, wherein a shield screen is arranged about the upper part of the body of the lineman.

In FIGS. 3 and 4 the apparatus **70** comprises a bucket **71**, such as the bucket **14** of FIG. 2, having conductive screens **72** and **73**, similar to the screens **56** and **57** of the liner **55** of FIG. 2. In the apparatus **70**, the shielding effect of the screen **56**, is augmented by a collapsible hood **74** formed of electrically conductive parts which extend over and above the upper part of the body of the lineman. The screens **72** and **73**, are connected to the line conductor **75**, by means of a cable connector **76**, similar to the cable connector **60** and the hood **74** is connected to the screens through the structural parts of the hood or energized by means of an auxiliary cable **77**.

The hood **74** is constituted by a plurality of rigid U-shaped metal frames **78**, **79**, **80** and **81**, pivoted upon two clamps **82** and **83** which are secured to the walls of the bucket **71**. A flexible wire mesh **84** extends over and is attached to the frames **78**, **79**, **80** and **81**, and the entire assemblage may be adjustably positioned by means of clamping screws **85** and **86**.

As shown particularly in FIG. 4, the hood **74** defines a shielded enclosure over the top of the bucket such that access to the line conductor **75** is had through the frame **78**. That is, the hood constitutes a shield means about three sides and above the body of the lineman. Accordingly, the top part of the body of the lineman is substantially shielded with respect to the electric field which would, otherwise, exist between that part of his body and ground.

In the apparatus of FIGS. 5 and 6, a bucket **88**, such as the bucket **14** of FIGS. 1 and 2, is provided with a shield enclosure **89** which extends over the bucket and over and about the upper part of the body of the lineman. The functioning of the enclosure **89** is similar to that of the hood **74**, but with a somewhat greater shielding effect, particularly at very high voltages.

The enclosure **89** is constituted by two side panels **90** and **91**, a top panel **92** and a back panel **93** each constituted by a rectangular frame work of light metal pieces, and each carrying a conductive screen in the form of a wire mesh. The lower side pieces **94** and **95** of the side panels **90** and **91** are positioned along the sides of the bucket **88** and are secured to the side wall of the bucket. The side pieces are held by metal fasteners which extend through a terminal member **96**, similar to the terminal member **59**, to provide an electrical connection between the wire mesh and the terminal member. The wire mesh of the panels, e,g, the wire mesh **97** of the side panel **90** and the wire mesh **98** of the back panel **93**, are secured to the frames for mechanical support and electrical interconnection to provide a screened enclosure extending about the three sides and over the top of the upper part of the body of a lineman standing in the bucket.

The open front side of the enclosure permits working access to a line conductor **100**, and a shelf **101** and a strip of wire mesh **102** are arranged transversely between the forward parts of the lower side pieces **94** and **95** and of the upper side pieces of the side panels **90** and **91**, respectively, to enhance the shielding effect of the enclosure. The frames of the panels may of course be constructed of wood or other insulating material with suitable connections between the wire mesh of the several panels and with the terminal **96**.

On the interior of the bucket **88** a generally rectangular frame **103** is secured to the terminal member **96** at the top of the bucket and to the floor **104** at the bottom of the bucket. A wire mesh **105** extends about the side pieces of the frame **103** and over the bottom **104** of the bucket.

In working an energized line according to the invention as embodied in the apparatus of FIGS. 1 and 2, the booms **21** and **22** and the buckets **14** and **15** are lowered into loading position on the vehicle **12**. In this position of the boom, a lineman may enter a bucket taking such measures as are provided for establishing bodily connection with the liner **55**. The lineman then operates the lift by means of the control levers **26** until the buckets are brought into a convenient working position adjacent the conductor **17** of the line. With the lift stopped in the desired position, the lineman attaches the clamp **62** to the line conductor **17**. Thereafter, the lineman may contact the line conductor freely in order to conduct the necessary service or repair work. Since the lineman is at the potential of the conductor, it is essential that he avoid contact with the cross arm and other portions of the support structure.

It is an important aspect of the practice of the invention that the connector **60** be attached to the line conductor **17** before any contact is made between the body of the lineman and the line conductor. As the connector **60** is brought into close proximity to the energized line conductor **17** an electric arc, having a length and intensity dependent on the system voltage and upon the size and location of the bucket in the electric field, will be formed between the conductor and the clamp **62**. On alternating current systems this arc will be extinguished and reestablished with each reversal of polarity of the energized conductor and a potential difference will continued to exist between the energized conductor and the screen of the bucket until the connection between the clamp **62** and the line conductor is established. This voltage could produce sufficient current through the body of result in a severe electric shock if the contact were established through the body of the workman. However, provision of the screen **57**, and the connection of the screen **57** to the line conductor prior to contact between the body of the lineman and the line conductor, insures that the transient current flow takes place in the screen **57** and the lineman is brought to line potential without subjective sensation or bodily effects of any kind.

The potential of the body of the lineman at a time just prior to contact with the line conductor is determined largely by the capacitances which exist between the body of the lineman (or would exist in the absence of screens **56** and **57**) and the conductor **17** and the earth. Direct contact between the body of the lineman and the line conductor would result in a transient current flow in the body of the lineman at the time of making contact with the line conductor due to the change in body potential.

It will be apparent from the foregoing that the practice of the present invention wholly avoids one of the limitations of live line maintenance by conventional methods. This limitation results during inclement weather since moisture on the surfaces of the insulating parts of the insulated tools provides an electrically conducting path and the lineman forms a part of a series circuit which is established between the energized conductor and ground. By contrast the lineman in the bucket or personnel carrier of the invention is not a part of the circuit which results from the development of leakage paths along the insulating parts which support the bucket or personnel carrier (e.g. the part **38** of the boom **22**). The screen members are effective as a shunt so that the lineman is in no danger even though substantial leakage currents flow from the line conductor through the boom to ground.

Practice of the invention is not limited to the aerial lift and insulated boom structure of FIGS. 1 and 2. Thus, in the practice of the invention according to FIG. 7, an aerial tower **108** is mounted upon a vehicle **109**

and supports a personnel carrier **110**. The tower **108** comprises a telescoping frame **111** and telescoping hydraulic cylinders **112** which are operable to elevate the carrier **110** with respect to the vehicle **109**.

The personnel carrier **110**, comprises a metal platform **113** which is mounted upon a head **114**, secured to the top of the aerial tower **108** by means of insulators **115**. The platform **113** is of known grill, mesh or solid construction and has an exposed conductive surface which may be contacted by the lineman.

In accordance with the invention the platform **113** is energized from the line conductor **116** by means of a cable connector **117**, which is connected to the line conductor and to the metal platform. Inasmuch as the platform is electrically conductive and is insulated from the tower **108** and from the ground, the platform functions as a conductive screen and serves to energize the lineman to the potential of the line conductor **116**.

In the apparatus of FIG. 8 a personnel carrier **120** is supported on a shaft **121** which is carried by an insulated boom of a mechanical arm—such as the boom **22** of the lift **11**. The carrier **120** comprises a metal platform **122** of grill, mesh or solid construction, similar to the platform **113**, and supported on a member **123** which is secured to the shaft **121**.

The platform **120** is provided with a metal guard rail **124** and a wire mesh **125** is attached to the guard rail. The platform **120** is connected to the line conductor by means such as the connector **117**. Accordingly, the platform **120** functions as a shield means and energizing means, similar to the screen **105** in the apparatus of FIG. 7 and the guard rail **124** and mesh **125** function as a shield means, similar to the screen **56** in the apparatus of FIG. 2. The hood of FIGS. 3 and 4 may be secured to the top portion of the guard rail.

The invention may be practiced by using an aerial ladder in which there is a metal upper ladder or ladder part of and a lower ladder or ladder part of structural insulating material supporting the upper part. The upper part of the ladder is conductively connected to the energized conductor or equipment so that a lineman wearing conductive sole shoes and standing on a metal rung of the upper part may contact the conductor or equipment. Such embodiments are useful particularly in working energized conductors in sub-stations and the like.

It is to be understood that the foregoing description is not intended to restrict the scope of the invention and that various rearrangements of the parts and modifications of the design may be resorted to, giving effect to a liberal interpretation of the claims as herein set forth.

I claim:

1. That method of working an energized line conductor which is supported in spaced and insulated relation to the earth, which comprises supporting a conductive member and a workman on the conductive member insulated from energized line conductor bringing the said conductive member and workman into the vicinity of the conductor in electrically insulated relation to earth, and establishing an electrically conductive connection between the conductive member and the line conductor to bring the body of the workman to the potential of the conductor in working relation thereto without adverse bodily effects.

2. The method in accordance with claim 1 including as a step thereof, establishing an electrically conductive connection between the body of the workman and the conductive member while the conductive member is insulated from the energized line conductor.

3. That method of working an energized line conductor which is supported above the earth in spaced and insulated relation thereto, which comprises supporting a workman on a personal carrier having a conductive screen constituting a shield between the body of the workman and the earth, first maintaining the conductive screen in insulated relation to the energized line conductor while establishing an electrically conductive connection between the body of the workman and the screen, elevating the carrier into the vicinity of the line conductor in electrically insulated relation to earth, and thereafter establishing an electrically conductive connection between the conductive screen of the personnel carrier and the line conductor to bring the body of the workman from a potential between that of the line conductor and earth to the potential of the conductor, whereby the workman may contact the line conductor in working relation thereto without adverse bodily effect.

4. In apparatus for working an energized line conductor which is supported in spaced and insulated relation to the earth, means for elevating a workman to a working position adjacent the line conductor and comprising an aerial lift and a personnel carrier for supporting the workman, means electrically insulating the personnel carrier from the earth and from the energized conductor, and means on the carrier for energizing the workman to the potential of the line conductor.

5. Apparatus in accordance with claim 4 in which the last named means comprises an electrically conductive member extending over the floor of the carrier to constitute a shield means between the body of the workman and the earth and normally disconnected means for connecting the conductive member to the line conductor.

6. Apparatus in accordance with claim 5 in which the conductive member is in the form of an enclosure open above, and has an exposed surface adapted to be electrically contacted by a workman standing thereon.

7. Apparatus in accordance with claim 5 with means for establishing an electrically conductive connection between the body of the workman and the conductive member.

8. In apparatus for working an energized conductor which is supported above the earth in spaced relation thereto, means for elevating a workman from the earth to a working position adjacent the line conductor comprising an aerial lift, a personnel carrier for supporting the workman, and means embodied in the lift electrically insulating the carrier from the earth, a first conductive screen extending over the floor of the carrier, and a second conductive screen extending upwardly from the first conductive member, the said conductive screens constituting a shield means between at least the lower part of the body of the workman and the earth.

9. Apparatus in accordance with claim 8, in which the first conductive screen has an exposed surface and is adapted to be electrically contacted by a workman standing thereon for energizing the body of the workman to the potential of the line.

10. Apparatus in accordance with claim 8 in which the said screens are formed as integral parts of the said personnel carrier.

11. Apparatus in accordance with claim 8 with means for electrically connecting the said conductive screens to the line conductor.

12. Apparatus in accordance with claim 11 with means for establishing an electrically conductive connection between the body of the workman and a conductive screen.

13. Apparatus in accordance with claim 8 in which the aerial lift comprises a mechanical arm having a boom pivotally supported at one end thereof for elevating movement, the insulated means comprises a structural section of insulating material in the boom, and the personnel carrier comprises a bucket of structural insulating material.

14. Apparatus in accordance with claim 13 in which the said conductive screens comprise wire mesh liners extending about the interior and across the bottom of the bucket.

15. Apparatus in accordance with claim 14 with means comprising a wire mesh extending upwardly from the basket on the three sides away from the line conductor and over the top of the bucket for shielding the upper

part of the body of the workman standing in the bucket while providing working access to the line conductor.

16. In apparatus for working on energized conducting parts of electrical equipment and the like, means for elevating a workman from the ground to a working position adjacent the energized parts comprising an aerial lift having a boom, a personnel carrier comprising a bucket of rigid electrically insulating material carried at the end of the boom, the bucket having substantially vertical sides, a bottom and an open top, and a structural section of insulating material in the boom for electrically separating the bucket from the remainder of the lift, a conductive liner extending about the interior of the bucket, and means for connecting the said liner to the energized equipment.

17. Apparatus in accordance with claim 16 in which the liner comprises a wire mesh extending across the bottom of the bucket and adapted to be electrically contacted by the workman for energizing the body of the workman to the potential of the line conductor, that portion of the liner extending along the interior of the walls comprising an electrical shield for the body of the workman, and the bucket comprising an insulating barrier for the liner.

18. Apparatus in accordance wtih claim 16 with terminal means for the liner comprising a metal terminal member extending circumferentially about the bucket for securing the liner to the bucket and comprising an electrical shunt for the liner.

19. Apparatus in accordance with claim 16 with screen means extending upwardly away from and over the bucket to define a shielded region over and about the body of the workman.

20. Apparatus in accordance with claim 19 in which the screen means comprises a frame support on the bucket and a metal wire mesh between the members of the frame and extending along three sides and over the top of the bucket.

21. For use with an aerial lift in which a bucket of structural insulating material is provided for supporting a workman adjacent an elevated conductor, an electrically conductive liner for the bucket comprising a generally rectangular extent of wire mesh adapted to be arranged over the bottom and along the interior of the walls of the bucket, and means for securing the said wire mesh to the bucket.

22. Apparatus in accordance with claim 21 in which last named means comprises a rigid metal member adapted to be secured to the bucket about the top extremity thereof in electrically conductive contact with the wire mesh and constituting a terminal means for the liner.

23. Apparatus in accordance with claim 21, with means for connecting the liner to the conductor.

24. A shielded enclosure for working an energized conductor comprising a generally rectangular extent of conducting sheet material having vertically extending walls and bottom and top parts having a transverse and vertical spacing sufficient for a workman to stand therein and constituting an electrical screen about the workman, an opening in the upper part of one wall of the enclosure for working access to a conductor positioned adjacent the enclosure and means for supporting the enclosure.

25. That method of working an energized line conductor which is supported above the earth in spaced and insulated relation thereto, which comprises supporting a workman on a personnel carrier having a conductive screen constituting a shield which extends about the body of the workman, moving the personnel carrier and workman into the vicinity of the conductor in electrically insulated relation to the earth, and establishing an electrically conductive connection between the conductive screen of the personnel carrier and the line conductor to bring the body of the workman to the potential of the conductor in working relation thereto without adverse bodily effects.

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