# United States Patent [19]

**Hansen et al.**

[11] **3,829,603**

[45] **Aug. 13, 1974**


[54] **POWER CABLE WITH GROUNDING CONDUCTORS**


[75] Inventors: **Theodore E. Hansen; Thomas M. Moran**, both of Marion, Ind.

[73] Assignee: **The Anaconda Company**, New York, N.Y.



[22] Filed: **Apr. 26, 1973**

[21] Appl. No.: **354,813**

[52] **U.S. Cl.** ..... **174/115**, 174/36, 174/116

[51] **Int. Cl.** ..... **H01b 7/18**, H01b 9/02

[58] **Field of Search** ..... 174/115, 116, 113 R, 36, 174/102 R, 105 R, 106 R



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,904,472 | 4/1933 | Kent | 174/116 X |
| 2,258,687 | 10/1941 | Peterson | 174/115 |
| 3,614,300 | 10/1971 | Wilson | 174/115 |
| 3,644,659 | 2/1972 | Campbell | 174/116 X |
| 3,707,595 | 12/1972 | Plate | 174/115 |

OTHER PUBLICATIONS

G. Kardos, Development of Plastics Cables in Hungary, Electrical Times, Vol. 161, No. 5, Feb. 3, 1972 pp. 43–45.



*Primary Examiner*—Arthur T. Grimley

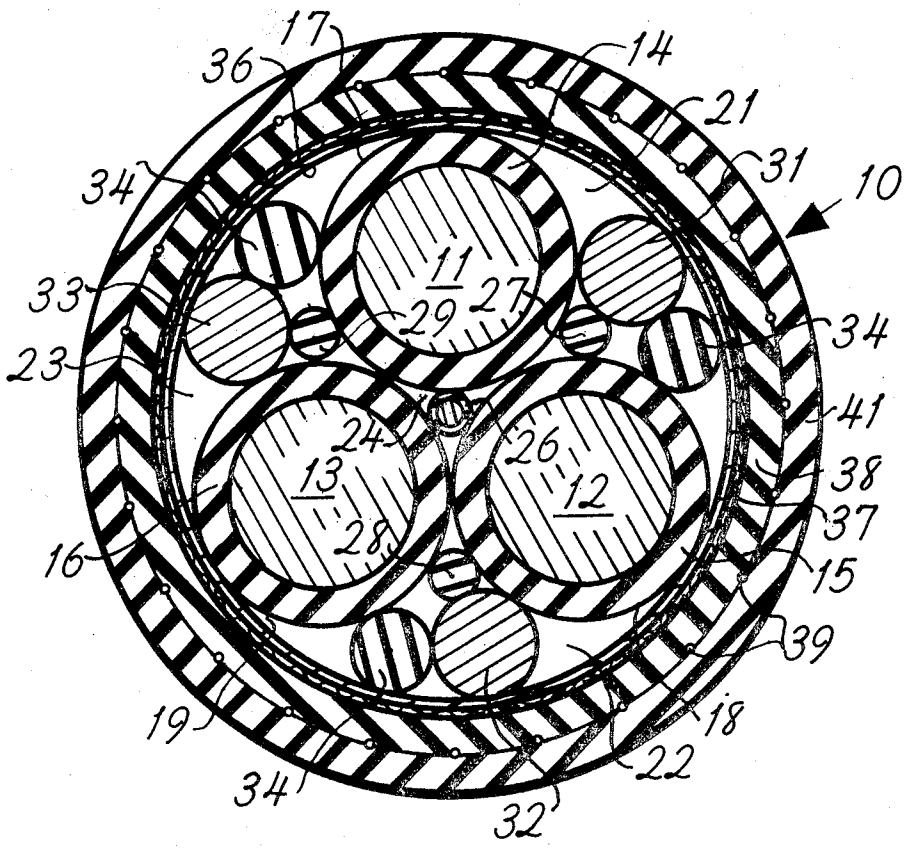
*Attorney, Agent, or Firm*—Victor F. Volk



[57] **ABSTRACT**

A power cable with uninsulated grounding conductors in the interstices between the insulated conductors has a helical winding of grounding wires. The grounding conductors are urged into contact with the helical wires by beddings of resilient filler material.


**6 Claims, 2 Drawing Figures**



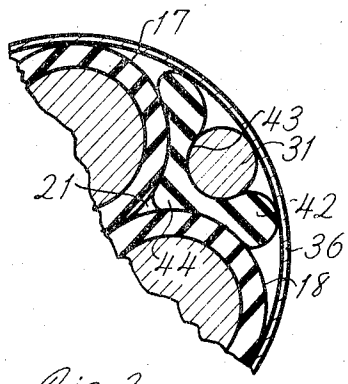

17
43
31
21
42
36
44
18

Fig. 2

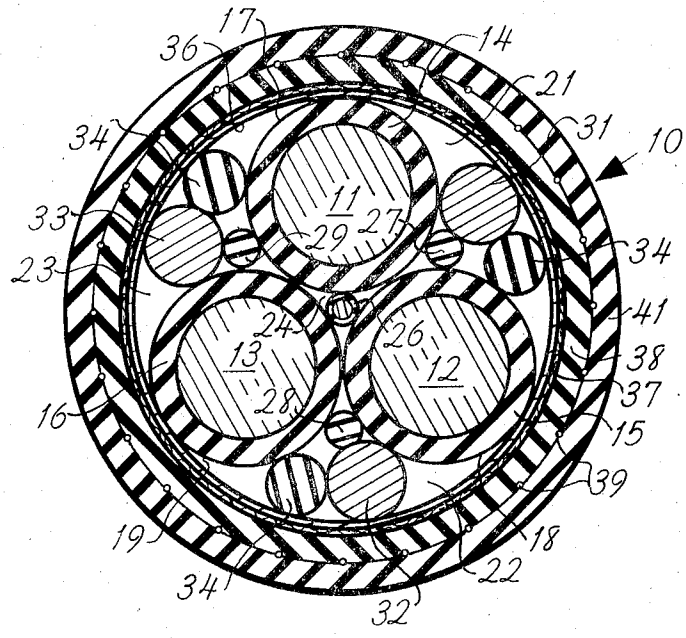

17
36
14
21
34
31
10
11
27
29
33
23
34
41
24
26
13
12
38
28
37
16
15
39
19
18
34
22
32

Fig. 1

# POWER CABLE WITH GROUNDING CONDUCTORS

## BACKGROUND OF THE INVENTION

In electric cables with grounding conductors it has been known to fit the grounding conductors into the interstices of the insulated conductors when the cable is stranded. Such a construction is disclosed for a mining machine cable in Hansen and Wilson U.S. Pat. No. 3,699,238 wherein the spaces of the interstices over the grounding conductor are rounded out with neoprene filler. When one of these grounding conductors opens at some point, and this eventually happens in cables that are subjected to repeated severe flexing, it no longer shares the load of any grounding current, and, of course, when all the grounding conductors have opened, the cable is no longer grounded.

## SUMMARY

We have invented a cable, and particularly a flexible cable wherein a grounding conductor in an interstice may open at one or more points, and still function to carry grounding current. In fact, all the grounding conductors may be open at some points without ungrounding the present cable which comprises a plurality, such as but not limited to, three, of insulated power current conductors, stranded together; a plurality of strands of resilient filler material, which may comprise outwardly facing grooves, laid in interstices between the insulated conductors; and a plurality of uninsulated grounding conductors laid in the interstices over the strands. These are supported in the grooves when the strands comprise grooves. Our cable also comprises at least one uninsulated grounding wire wound helically around the insulated and the grounding conductors which latter are urged outwardly by the filler strands against the grounding wire, and an abrasion-resistant jacket surrounding the grounding wire.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a section of a cable of our invention.

FIG. 2 shows a partial section of the cable of FIG. 1 comprising an alternative filler strand.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

A cable, indicated generally by the numeral **10**, shown in FIG. **1**, applies the improvement of our invention to the flexible mining machine cable disclosed in U.S. Pat. No. 3,699,238, incorporated herein by reference. The cable **10** has **3** flexible-stranded 4/0 Awg tinned-copper conductors **11, 12, 13** with respective 80-mil walls of insulation **14, 15, 16** to comprise insulated power current conductors designated **17, 18, 19.** The insulated conductors **17–19** are triplexed together with a left hand lay providing interstices **21, 22, 23** and a central opening **24** containing an insulated ground check strand **26.** At the base of the interstices **21–23** we have laid resilient filler strands **27, 28, 29** which are conveniently formed by extruding rods of neoprene or rubber. Other materials such as twisted fibers can be used for the strands **27–29** so long as they have sufficient nerve or resiliency to continue to recover from compression for indefinite periods of time. Pasty materials or materials that are plastic in the sense that they are subject to permanent compressive deformation are not suitable for the strands **27–29.** Over the strands **27–29** within the interstices **21–23** we have laid three 3 Awg grounding conductors **31, 32, 33** stranded from tinned copper wires. The size of the strands **27–29** is selected sufficiently large to project the surfaces of the conductors **31–33** radially outwardly of the circle inscribing the conductors **17–19.** The illustrated cable **10** is constructed to have a cylindrical outer surface. Where circularity of the cable section is not required it is at least necessary that the surfaces of the conductors **31–33** project beyond the tangent lines connecting the surfaces of the insulated conductors so that these surfaces will be urged against any wrappings that are applied around the assembled conductors. Where, as in the present cable **10,** it is desired to produce a cylindrical cable, additional filler material, not necessarily resilient, may be added such as filler strands **34.**

A grounding wire **36** is helically wrapped over the insulated conductors **17–19** and grounding conductors **31–33** making permanent electrical contact with the latter.

The act of wrapping the wire **36,** or a plurality of such wires, compresses the adially projecting grounding conductors **31–33** into the esilient filler strands **27–29** hich thereafter maintain a pressure of the grounding conductors against the grounding wire. The wire **36** is one of seven 28 Awg wires wound in parallel with a right hand lay. It might, however, within the scope of our invention be comprised in a braided tape, or take the form of a flat wire of substantial width. The essential feature of the wires **36** is that they comprise a large plurality of electrically conducting members connecting the conductors **31–33** circumferentially at many points along the cable **10.**

Over the wires **36** we have wrapped a fiber reinforced conventional binder tape **37** and extruded a neoprene or other abrasion resistant jacket **38.** This is surrounded by an open weave nylon seine twine reinforcing web **39** and a second abrasion resistant extrusion **41.**

In the embodiment of FIG. **2** a resilient filler strand **42** has been extruded in a shape providing a lengthwise groove **43** to support the grounding conductor **31.** The strand **42** has a restricted section **44** that nests into the base of the interstice **21** and comprises more positive means of securing the continued proper positioning of the grounding conductor against the grounding wires **36.** The number of strands **42** used in any cable will equal the number of interstices bearing grounding conductors.

In the manufacture of the cable **10** it is economical to apply the grounding wires **36** with the same length of lay and in the same operation as that for the application of the tape **37** and, indeed, the wires **36** may first have been bonded against the underside of the binder tape.

The foregoing description has been exemplary, rather than definitive, of the cable of our invention for which we desire an award of Letters Patent as defined in the appended claims.

We claim:

**1.** A power cable comprising:

A. a plurality of insulated power current conductors stranded together, interstices being formed between adjacent of said conductors,

B. a plurality of strands of resilient filler material laid in said interstices,

C. a plurality of uninsulated grounding conductors laid in said interstices over said strands,

D. at least one uninsulated grounding wire wound helically around said insulated conductors and said grounding conductors, said grounding conductors being urged outwardly by said strands against and in electrical contact with said grounding wire,

E. an abrasion-resistant polymeric jacket surrounding said grounding wire.

**2.** The cable of claim **1** wherein said plurality of insulated conductors is three.



**3.** The cable of claim **1** wherein said plurality of grounding conductors is three.

**4.** The cable of claim **1** wherein said filler strands define outwardly facing grooves, said grounding conductors being supported in said grooves.

**5.** The cable of claim **4** wherein said plurality of insulated conductors is three.

**6.** The cable of claim **4** wherein said plurality of grounding conductors is three.

* * * * *