Jan. 4, 1944. J. W. SCHMIED 2,338,304

ARMORED CONDUCTOR STRUCTURE

Filed March 14, 1942

FIG. 1

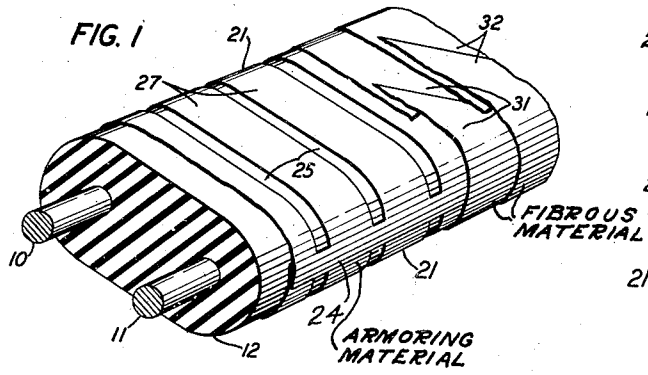


FIG. 2. FIG. 2A.

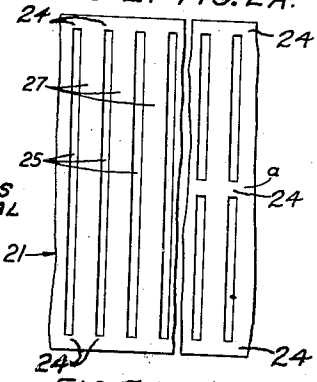


FIG. 3

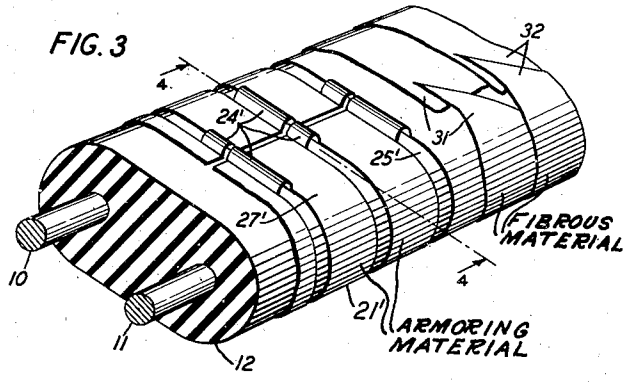


FIG. 5. FIG. 5A.

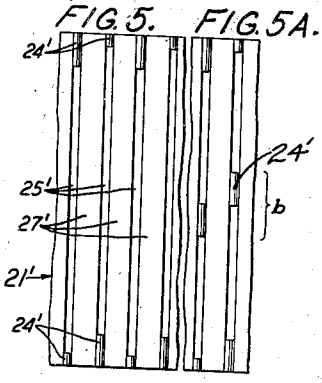


FIG. 4

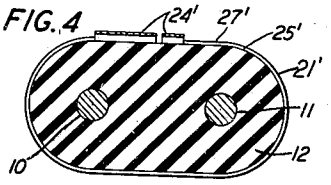


FIG. 6

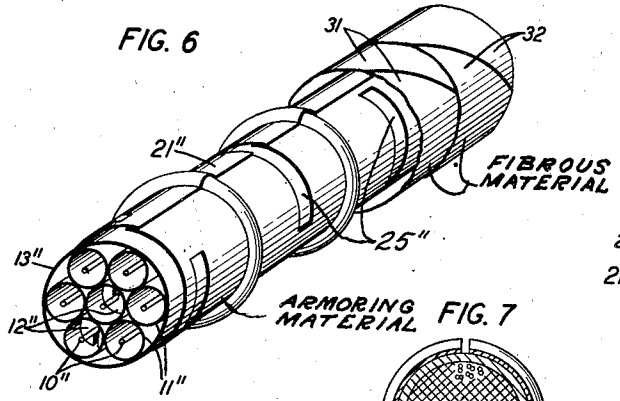


FIG. 8

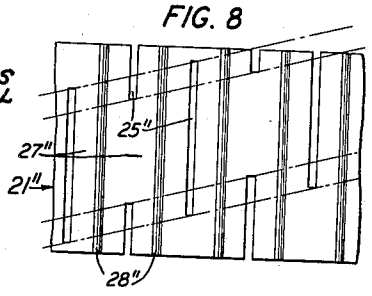
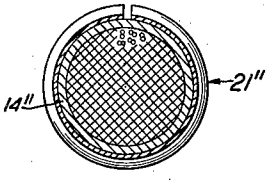


FIG. 7



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ARMORED CONDUCTOR STRUCTURE

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10 Claims. (Cl. 174—102)

This invention relates to armored conductor structures and more particularly to structures of this kind intended for burial directly in the ground.

It is an object of the invention to provide an armored cable structure which is simple to produce, easy to lay and which will provide safe protection against attacks by burrowing rodents.

The requirements of a cable of this type capable of answering these objects are as follows: The construction should be as light as possible to reduce cost of material and to simplify transportation and handling; the armoring should cover the insulated wires as completely as possible to give adequate protection against attacks and, on the other hand, should permit bending of the cable on a comparatively small radius without undue deformation of the armoring, thus permitting the use of comparatively small reels; the structure should be non-tangling and should present a smooth surface to facilitate general handling.

In accordance with the invention, a cable structure of this kind is provided which includes a single layer of armoring tape. The layer of armoring is formed of armoring tape of suitable materi l and applied longitudinally of the conductor structure. The armoring forms a continuous layer entirely enclosing the insulated conductor or conductors, except for narrow transverse openings cut in the material at frequent intervals to permit bending of the armored structure without appreciable buckling of the tape material.

In accordance with one arrangement of the invention, the tape has continuous solid edges and the transverse openings may be alined with corrugations to increase the flexibility of the armored cable.

In an alternative arrangement of the invention, the transverse openings may be alternated with transverse corrugations.

In these arrangements the openings and, if desired, also the corrugations may be shifted transversely relatively to adjacent openings and corrugations in order to more evenly distribute the forces acting on the tape, when the armored conductor is bent, and tending to buckle the armoring material and possibly to open the seam.

The openings and corrugations in the body portion of the tape are wide enough to prevent crowding of the tape material on the inside of the bend without buckling, when the conductor is bent on a fairly small radius, and narrow enough not to unduly expose the insulated conductor when widened on the outside of the bend. Other features of the invention will appear from the following detailed description.

The invention will now be described as applied in a practical embodiment of its various features and reference will be made to the accompanying drawing, in which:

Fig. 1 is a perspective view of a two-conductor armored cable structure with parts broken away to more clearly show the construction;

Fig. 2 is a plan view of the armoring tape used in the structure of Fig. 1; a modification is shown in Fig. 2A;

Fig. 3 is a perspective view of a two-conductor armored cable structure similar to that shown in Fig. 1 but using a modified construction of armoring tape;

Fig. 4 is a cross-sectional view of the cable shown in Fig. 3;

Fig. 5 is a plan view of the armoring tape used in the structure of Fig. 3; a modification is shown in Fig. 5A;

Fig. 6 is a perspective view of a multiconductor armored cable structure, using an armoring tape different from those shown in Figs. 1 and 3;

Fig. 7 is a cross-sectional view of an armored cable similar to that shown in Fig. 6 but having a different conductor arrangement; and

Fig. 8 is a plan view of the armoring tape used in the structure of Figs. 6 and 7.

Referring now to Figs. 1 and 2, the cable structure comprises two conductors 10 and 11 placed in parallel relation throughout the structure and enclosed in insulating material 12, which may form a single continuous body or comprise two separate bodies of insulation, one about each conductor. The tape armoring surrounding the insulation 12 comprises an armoring tape 21 of suitable material for protection against gopher attacks. The structure may further include outer wrappings, such as 31 and 32, applied about the armoring tape.

This structure, containing two parallel conductors, thus is substantially oval-shaped, having two comparatively flat sides and two rounded sides or edges. Whereas the armoring tape shown in Fig. 1 is particularly adapted for the oval structure, it may readily be adapted for structures of circular or other cross section. The armoring tape is shown more in detail in Fig. 2 in the form in which it is manufactured before application to the cable structure.

The tape 21 presents a flat surface. In effect, it is subdivided into strip portions or sections 27 by narrow transverse openings 25, the strips be-

ing interconnected by means of short connecting portions 24 disposed in longitudinal rows along both edges of the tape. If desired, a row of connecting portions 24 may be disposed along the central line of the tape as shown at *a* in Fig. 2A.

The tape 21 is applied longitudinally about the insulation 12 so as to form a seam along one rounded edge of the cable with an appreciable overlap. In the case where the tape has a central row of connecting portions 24, this row will be disposed along the other rounded edge of the cable. In this manner a series of closely spaced transverse openings are disposed along each of the flat surfaces of the cable.

The tape material may be iron or steel or any suitable composition and may or may not have its surface treated, as by tinning or galvanization. The material may be non-oxidizing and acid resistant to have a long life in contact with earth and other substances present in the ground.

The openings in the completed armoring should be not more than ⅛ inch and should preferably average about 1/16 inch in width. This is to permit laying the cable in the ground with fairly sharp curves or bends without unduly exposing the insulation to gopher attacks when the openings are widened on the outside of the bend. On the other hand, openings of this width will also prevent crowding of the tape material on the inside of the bend, when the cable is laid or when it is reeled, so that the armoring tape will not be unduly deformed and forced out of position, thereby exposing the insulation to gopher attacks.

It has been found that by means of these narrow transverse openings the tape portions forming the main surface of the armoring are free to shift slightly along the cable surface either to widen the openings or to close them up when the cable is bent and therefore the tendency to buckle and expose the underlying cable insulation is absent when small cables are wound on their flat sides on reels as small as 12 inches in diameter.

It has also been found that the introduction of narrow transverse openings in the tape material, particularly on the flat side of the cable, is effective in reducing the usual stiffness of armored cables of this general type and in easing the handling thereof both in factory and field.

Inasmuch as the cable when bent will be distorted on the inside and the outside of the bend with little distortion along a plane through the two conductors, it will be apparent that the solid edge portions along the seam on the rounded edge will be subject to little distortion and thus will not tend to buckle and expose the cable to attacks and will not appreciably impair the flexibility of the cable.

The modified cable structure shown in Figs. 3 and 4 is similar to that shown in Fig. 1, but differs therefrom by having an armoring tape 21', as shown in Fig. 5. The armoring tape 21' has a series of transverse strip portions 27' separated by transverse openings 25' and the connecting portions 24' between the strips are crimped to form rows of corrugations along the edges of the tape and, if desired, another such row of corrugations may be disposed along the center line of the tape as shown at *b* in Fig. 5A.

With the solid edges of the tape made more flexible, as compared with those in Fig. 2, by means of the corrugations 24' the tape in Fig. 5 may be applied against one flat side of the cable and return-bent about the rounded sides to form a longitudinal seam along the other flat side of the cable. Thus, when the cable is bent the corrugations will tend to stretch on the outside of the bend and to close up on the inside of the bend, thereby reducing the tendency of the flat strip portions 27' to buckle and thus insuring that the seam will remain closed.

Referring now particularly to Figs. 6, 7 and 8 of the drawing, the cable structure is of the circular type and comprises a plurality of paired conductors. Thus, as shown in Fig. 6, each conductor pair 10'' and 11'' may form a concentric pair separated by insulating washers 12'' in any well-known manner and the cable may contain four or more such pairs. However, the cable may contain a single concentric pair. The cable may, however, also be of the usual multiconductor type with a large number of pairs or quads arranged in any well-known manner, as shown diagrammatically in Fig. 7.

The bundle of conductors may be held together by a binding or a sheath 13'' or they may be enclosed in a lead sheath 14'' as shown in Fig. 7 for protection of the hygroscopic insulating material against moisture.

Whatever the construction of the conductor cable, the armoring 21'' is applied directly thereto in the form of a continuous tape with a longitudinal seam, with or without overlap as desired. The tape armoring may further be surrounded by outer wrappings 31 and 32.

The armoring tape used in the cable shown in Figs. 6 and 7 is shown more in detail in Fig. 8 in the form in which it is manufactured before application to a cable structure. The tape 21'' is continuous and has transverse openings 25'' at frequent intervals along any surface line and has also transverse corrugations 28'' in the strip portions 27''.

The transverse openings are appreciably shorter than the tape width and are arranged so that any one opening is shifted about halfway around the cable relative to the immediately adjacent openings, alternate openings being on opposite sides of the cable. The openings are furthermore shifted a small amount in the transverse direction progressively along the cable and thus are disposed along a helix with a long pitch. Thus, the helically disposed openings will be variously distributed with respect to the seam of the armoring tape and the forces acting on the tape material when the cable is bent will be variously distributed with respect to the seam, thereby reducing any cumulative effect of the strains in the tape material along the seam when the cable is bent in any direction.

The outer wrappings 31 and 32 may be of fibrous material, such as paper, and are helically applied in tape form. The wrappings may be impregnated or coated with any suitable substance to retard their deterioration. They are particularly effective in holding the tape tightly in position about the cable, when the cable is reeled and unreeled and assumes its final shape after laying.

Cables of the type described above and shown in Figs. 1 and 3, may be used for supplying electric light and power or for communication purposes. Since they are particularly adapted for use in rural areas the distances over which such cables will be used are usually quite considerable. It is therefore of great importance that the cost

of manufacture and the cost of transportation and laying be as low as possible.

These self-contained cable structures, including also those shown in Figs. 6 and 7, are therefore preferable over cables made in conduits, since the cable may be plowed down in a fast continuous process from reels of reasonable size. The described structures are readily unbent from the reel and laid in sharp curves without danger of the tape buckling and unduly opening along the seam. With one or two wrappings outside the armoring there is no danger of tangling or catching as the cable leaves the reel and the cable may also readily be manipulated by hand without danger of injury.

The described structures lend themselves particularly to fast manufacturing as compared with cables having helically armored tapes, since the longitudinal tape may be applied and locked in position as fast as the insulated conductor structure can be produced.

Due to the fact that the finished armoring is in effect broken up into a large number of small shields or strips separated by narrow openings, a degree of flexibility may be secured which is at least as high as with helically applied armoring tape.

The absence of buckling of the armoring is especially important in assuring definite protection against gopher attacks and is attained by the introduction of the transverse openings in the material which will permit a slight shifting of the armoring material relatively to the insulation, particularly on the inside of the bend, when the cable is bent. The armored cable may therefore be wound on reasonably small reels without danger of opening up along the seam. Thus storage, transportation and laying is greatly facilitated.

It should be understood that the cables shown in Figs. 1 and 3 may include more than two conductors arranged in a single layer and may contain more than one such layer of a plurality of conductors.

1. A long insulated conductor, tape armoring placed tightly about and longitudinally of said insulated conductor, said tape armoring forming a single generally continuous layer enveloping said conductor and having narrow openings extending transversely of said conductor, said openings being disposed at frequent intervals along said conductor and being adapted to close up on the inside of the bend, when the conductor is bent, thereby reducing buckling of the armoring tape, said tape armoring comprising an armoring tape forming said single generally continuous layer without overlapping portions and including short offset connecting pieces across said openings, each of said transverse openings extending entirely around said conductor.

2. A long insulated conductor, tape armoring placed tightly about and longitudinally of said insulated conductor, said tape armoring forming a single generally continuous layer enveloping said conductor and having narrow openings extending transversely of said conductor, said openings being disposed at frequent intervals along said conductor and being adapted to close up on the inside of the bend, when the conductor is bent, thereby reducing buckling of the armoring tape, said tape armoring comprising an armoring tape forming said single generally continuous layer without overlapping portions and having transverse interruptions in said layer each extending entirely around said conductor and being formed partly by one of said openings in the armoring material and partly by a plurality of short crimps of about the same width as the opening.

3. A long insulated conductor, tape armoring placed tightly about and longitudinally of said insulated conductor, said tape armoring forming a single generally continuous layer enveloping said conductor and having narrow openings extending transversely of said conductor, said openings being disposed at frequent intervals along said conductor and being adapted to close up on the inside of the bend, when the conductor is bent, thereby reducing buckling of the armoring tape, said tape armoring comprising an armoring tape forming said single generally continuous layer without overlapping portions and having two continuous intermittently corrugated body portions along opposite sides of said conductor and each of said transverse openings extending entirely around said conductor.

4. A long insulated conductor, tape armoring placed tightly about and longitudinally of said insulated conductor, said tape armoring forming a single generally continuous layer enveloping said conductor and having narrow openings extending transversely of said conductor, said openings being disposed at frequent intervals along said conductor and being adapted to close up on the inside of the bend, when the conductor is bent, thereby reducing buckling of the armoring tape, said tape armoring comprising an armoring tape forming said generally continuous layer with a seam disposed parallel with the conductor axis, said openings being successively displaced about said conductor to generally follow a center line forming a helix with a long pitch.

5. A long insulated conductor, tape armoring placed tightly about and longitudinally of said insulated conductor, said tape armoring forming a single generally continuous layer enveloping said conductor and having narrow openings extending transversely of said conductor, said openings being disposed at frequent intervals along said conductor and being adapted to close up on the inside of the bend, when the conductor is bent, thereby reducing buckling of the armoring tape, said tape armoring comprising an armoring tape forming said generally continuous layer with a seam disposed parallel with the conductor axis and including small connecting portions across said openings for forming a continuous structure and disposed along the edges of said seam to form solid edge portions.

6. A long insulated conductor, tape armoring placed tightly about and longitudinally of said insulated conductor, said tape armoring forming a single generally continuous layer enveloping said conductor and having narrow openings extending transversely of said conductor, said openings being disposed at frequent intervals along said conductor and being adapted to close up on the inside of the bend, when the conductor is bent, thereby reducing buckling of the armoring tape, said tape armoring comprising an armoring tape forming said generally continuous layer with a seam disposed parallel with the conductor axis and including small connecting portions across said openings for forming a continuous structure and disposed along the edges of said seam to form solid edge portions, the edge portion of the tape being corrugated at frequent intervals.

7. A long insulated conductor, tape armoring placed tightly about and longitudinally of said

insulated conductor, said tape armoring forming a single generally continuous layer enveloping said conductor and having narrow openings extending transversely of said conductor, said openings being disposed at frequent intervals along said conductor and being adapted to close up on the inside of the bend, when the conductor is bent, thereby reducing buckling of the armoring tape, said tape armoring comprising an armoring tape forming said generally continuous layer with a seam disposed parallel with the conductor axis, said tape armoring including small connecting portions across said openings for forming a continuous structure and disposed along the edges of said seam to form solid edge portions, the edge portions of said armoring tape having transverse corrugations alined with said transverse openings.

8. A long insulated conductor, tape armoring placed tightly about and longitudinally of said insulated conductor, said tape armoring forming a single generally continuous layer enveloping said conductor and having narrow openings extending transversely of said conductor, said openings being disposed at frequent intervals along said conductor and being adapted to close up on the inside of the bend, when the conductor is bent, thereby reducing buckling of the armoring tape, said tape armoring comprising an armoring tape forming said generally continuous layer with a seam disposed parallel with the conductor axis and including connecting portions across said openings for forming a continuous structure, said tape armoring having transverse corrugations alternating with said transverse openings.

9. An elongated insulated conductor, an armoring tape placed tightly about and longitudinally of said insulated conductor and forming a single generally continuous layer enveloping said conductor, said armoring tape being formed of a continuous series of transverse separated strip portions and including small connecting portions connecting adjacent strip portion together into a continuous structure without adding appreciable stiffness to said armoring, said strip portions being sufficiently separated to permit bending of the armored conductor on a small radius without appreciable buckling of the tape material in said strip portions, said strip portions being long enough in the transverse direction to be return-bent about the conductor and said connecting portions being corrugated and disposed along the edge portions of said tape.

10. An elongated insulated conductor, an armoring tape placed tightly about said conductor with a longitudinal seam and forming a single generally continuous layer substantially entirely enclosing said structure, said tape being formed of a continuous series of transverse separated strip portions and narrow connecting portions between adjacent strip portions, said strip portions being sufficiently separated to permit bending of the armored conductor on a small radius without crowding of the tape material, and the edge portions of said tape having a corrugation for each of said strip portions to reduce the stiffness of the seam.

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