

A System and Method for Installing an Earth Tape

The present invention relates to a system and method for installing an earth tape, and more particularly relates to a system and method for installing an
5 earth tape inside a tunnel.

It is often necessary to install an earth tape, also known as an earth bar, inside a tunnel in order to provide an electrical earth connection along the length of the tunnel. An earth tape is an elongate metal conductor which is usually
10 constructed from a solid copper core. An earth tape is typically rectangular in cross section with a width of approximately 10-70 millimetres and a thickness of approximately 1.5-15 millimetres.

An earth tape is usually supplied in a coil. In order to install the earth tape
15 along an elongate structure, such as a tunnel, the earth tape must first be uncoiled and straightened. Substantial forces are required to uncoil and straighten an earth tape, due to the thick metal core. In most cases, a manual straightening process is used to uncoil and straighten an earth tape to prepare the earth tape for installation.

20 A conventional manual straightening process can be used to straighten lengths of earth tape with a width of up to approximately 50 millimetres and a thickness of approximately 3 millimetres. However, a conventional manual straightening process is highly labour intensive and requires the use of large,
25 heavy machines that operate at a fixed location, such as a manufacturing plant. The machines are difficult and impractical to transport to a project site. Furthermore, it is not possible to operate the machines at a project site where space is limited, such as inside a tunnel with a diameter of only 6 metres.

Straightened sections of earth tape must therefore be transported from a manufacturing plant to the project site where the earth tape is being installed. This transportation of lengths of straightened earth tape is difficult and costly.

- 5 The present invention seeks to provide an improved system and method for installing an earth tape.

According to one aspect of the present invention, there is provided a system for installing an earth tape along an elongate surface within a tunnel, the
10 system comprising a moveable support arrangement which is configured to be moved relative to the elongate surface, the support arrangement comprising at least one wheel assembly, each wheel assembly incorporating a first wheel which is configured to rotate about a first axis and a second wheel which is configured to rotate about a second axis which is not parallel to the first axis
15 such that the first and second wheels are configured to contact an inclined surface of the tunnel simultaneously to allow the support arrangement to be moved along a length of the tunnel a coil support apparatus which is configured to support a coil of earth tape; and a straightening apparatus which is configured to receive successive sections of earth tape from the coil of earth
20 tape, straighten the successive sections of earth tape and output straightened sections of earth tape, wherein the coil support apparatus and the straightening apparatus are carried by the support arrangement and configured to be moved by the support arrangement relative to the elongate surface so that the straightened sections of earth tape can be installed along
25 at least part of the elongate surface within the tunnel.

Preferably, the coil support apparatus comprises a planar surface which supports at least part of the coil of earth tape, the planar surface being rotatable about an axis which is generally perpendicular to the planar surface.

Conveniently, the coil support apparatus comprises a spindle which extends generally perpendicularly from the planar surface, the spindle being configured to be received within an aperture positioned at the centre of the coil of earth tape.

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Advantageously, the straightening apparatus comprises at least two drive rollers which are spaced apart from one another, the drive rollers being configured to rotate and contact the successive sections of earth tape such that the rollers exert a force on the earth tape to uncoil the successive sections of earth tape from the coil of earth tape.

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Preferably, the straightening apparatus comprises at least two straightening rollers which are spaced apart from one another, the straightening rollers being configured to contact the successive sections of earth tape and to exert forces on the earth tape to straighten the earth tape.

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Conveniently, three of the five straightening rollers are positioned adjacent one side of the straightening apparatus and two of the five straightening rollers are positioned adjacent an opposite side of the straightening apparatus.

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Advantageously, the distance between each of the straightening rollers is adjustable so that the distance between the rollers can be set to match the thickness of an earth tape.

25 Preferably, the straightening apparatus comprises a motor which is configured to drive at least one of the rollers to exert a force on the earth tape to pull the earth tape through the straightening apparatus.

Advantageously, the system further comprises at least one further wheel assembly, the first and second wheels in each wheel assembly being

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configured to contact an inclined surface to moveably support the support arrangement.

Preferably, the system is dimensioned to fit inside and move along the inside
5 of a tunnel having a diameter of between 4 and 8 metres.

Conveniently, the moveable support arrangement comprises a raised support platform which supports the coil support apparatus and the straightening apparatus in a raised position relative to the base of the moveable support
10 arrangement.

Preferably, the system further comprises a hoist apparatus which is configured to hoist a coil of earth tape up and onto the raised support platform.

15 Advantageously, the support platform is raised by between 2 and 4 metres from the base of the moveable support arrangement such that the straightening apparatus outputs straightened sections of earth tape for installation at a raised position.

20 According to another aspect of the present invention, there is provided a method of installing an earth tape along an elongate surface within a tunnel, the method comprising rotatably mounting a coil of earth tape on a coil support apparatus, the coil support apparatus being carried by a moveable support arrangement which is configured to be moved relative to the elongate surface,
25 the support arrangement comprising at least one wheel assembly, each wheel assembly incorporating a first wheel which is configured to rotate about a first axis and a second wheel which is configured to rotate about a second axis which is not parallel to the first axis such that the first and second wheels are configured to contact an inclined surface of the tunnel simultaneously to allow
30 the support arrangement to be moved along a length of the tunnel positioning the moveable support arrangement within the tunnel; feeding one end of the

earth tape into a straightening apparatus which is carried by the support arrangement activating the straightening apparatus to pull successive sections of earth tape through the straightening apparatus to straighten the successive sections of earth tape moving the support arrangement adjacent to and along the elongate surface; and installing the straightened sections of earth tape along at least part of the length of the elongate surface within the tunnel.

Preferably, the method further comprises locking the support arrangement in position to install the straightened sections of earth tape along at least part of the length of the inside surface of the tunnel.

Conveniently, the tunnel has a diameter of between 4 and 8 metres.

Advantageously, the method further comprises moving the moveable support arrangement along the tunnel at a speed which matches the speed at which the straightened sections of earth tape are output from the straightening apparatus.

Preferably, the straightening apparatus comprises at least two straightening rollers which are spaced apart from one another and at least two drive rollers which are spaced apart from one another and the method further comprises adjusting the distance between each of the straightening rollers and each of the drive rollers such that the spacing between the rollers matches the thickness of an earth tape which is to be straightened by the straightening apparatus.

So that the present invention may be more readily understood, embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

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Figure 1 is a schematic diagram of a system of an embodiment of the invention in use within a tunnel,

Figure 2 is a diagrammatic side view of a support arrangement of the system
5 shown in figure 1,

Figure 3 is a diagrammatic top view of the system shown in figure 1,

Figure 4 is a diagrammatic side view of part of a coil support apparatus of an embodiment of the invention,

- 5 Figure 5 is diagrammatic top view of a straightening apparatus of an embodiment of the invention,

Figure 6 is diagrammatic side view of the straightening apparatus shown in figure 5,

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Figure 7 is a further side view of the straightening apparatus shown in figure 5, and

- 15 Figure 8 is a diagrammatic view of part of the system of an embodiment of the invention, showing an earth tape being uncoiled and straightened.

Referring initially to figures 1-3 of the accompanying drawings, a system of an embodiment of the invention comprises a moveable support arrangement 1 which is constructed from a plurality of interconnected metal sections. The support arrangement 1 comprises a first support structure 2 and a second support structure 3. The first and second support structures 2, 3 are substantially identical to one another and positioned on opposing sides of the support arrangement 1. For simplicity, the following description will refer to the first support structure 2, but it is to be appreciated that equivalent features are also present in the second support structure 3.

The first support structure 2 comprises four spaced apart pairs of upright sections 4a-d, 5a-d which extend along the length of the support arrangement 1. The pairs of upright sections 4a-d, 5a-d are spaced apart from one another and connected to one another by spacing bars 6. The upright sections 4a-4d,

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5a-d are coupled to one another by horizontal cross beams 7 and diagonal support struts 8.

5 A wheel assembly 9a-d is provided at the lower end of each of the upright supports 4a-d, 5a-d. Each wheel assembly 9a-d comprises an inner wheel 10 which is a castor wheel with the axis of rotation of the wheel is substantially perpendicular to the upright supports 4a-d, 5a-d.

10 Each wheel assembly 9a-d further comprises an outer wheel 11 which is a castor wheel that is mounted at an offset angle relative to the inner wheel 10 and the upright supports 9a-d. The lower edge of the outer wheel 11 is raised relative to the lower edge of inner wheel 10 such that the inner and outer wheels 10, 11 contact an inclined surface simultaneously to support the support arrangement 1. Each wheel assembly 9a-d is therefore configured to
15 contact the inclined inner surface of a tunnel, such as the tunnel 12 shown in figure 1. The wheel assemblies 9a-d are configured to support the support arrangement 1 on the inner surface of the tunnel 12 and configured to allow the support arrangement 1 to be moved along the length of the tunnel 12.

20 In this embodiment, one or more of the wheel assemblies 9a-d incorporates a locking arrangement which can be activated to lock the wheel assembly 9a-d to prevent the support arrangement 1 from moving along the tunnel 12. The support arrangement 1 can therefore be locked safely in position within the tunnel 12 while work is carried out.

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In this embodiment the support structure is configured to operate within a tunnel with a diameter of approximately 6 metres.

30 A central beam arrangement 13 connects the first support structure 2 to the second support structure 3. The central beam arrangement 13 is coupled to

the upper ends of the first and second support structures 2, 3 and retains the first and second support structures 2, 3 generally parallel to one another.

5 In this embodiment, a hoist apparatus in the form of a winch W is mounted on the central beam arrangement. The winch W is configured to hoist materials, such as a coil of earth tape, safely up and onto the central beam arrangement 13 for use on the raised platforms 14, 15.

10 First and second raised platforms 14, 15 project perpendicularly outwardly from the upper end of each respective support structure 2, 3. In this embodiment, the support platforms 14, 15 are raised by approximately 3 metres from the base of the support arrangement 1 and hence approximately 3 metres above the floor of the tunnel 12. In other embodiments, the support platforms 14, 15 are positioned between 2 and 4 metres above the base of the
15 support arrangement 1.

The raised support platforms 14, 15 enable a user to install an earth tape at a raised position within the tunnel 12. The raised platforms 14, 15 also enable a user to install structural, electrical and mechanical services on the upper part
20 of the tunnel 12.

In this embodiment the first and second platforms 14, 15 are substantially identical to one another. For simplicity, only the first platform 14 will be described below.
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In this embodiment, the first platform 14 is a generally planar surface formed by a metal grating that is supported by a metal frame. The first platform 14 is dimensioned to enable a user to stand on the platform 14 at a raised position within the tunnel 12.
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The raised platform 14 enables a user to install an earth tape at position which is raised above the floor of a tunnel. In this embodiment, the raised platform 14 enables a user to install an earth tape at a height of approximately 3 metres above the floor of a tunnel.

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Referring to figure 3 of the accompanying drawings, a coil support apparatus 15 and a straightening apparatus 16 are positioned on the first platform 14. Figure 3 also shows a further coil support apparatus and a further straightening apparatus which are positioned on the second platform 15.

10 However, it is to be appreciated that in other embodiments of the invention the further coil support apparatus and the further straightening apparatus are omitted so that the system only incorporates one coil support apparatus and one straightening apparatus.

15 For simplicity, only the coil support apparatus 15 and the straightening apparatus 16 on the first platform 14 will be described below.

The coil support apparatus 15 is mounted to the first platform 14 at a position which is spaced apart from the straightening apparatus 16. The coil support
20 apparatus 15 and the straightening apparatus 16 are integrated with the moveable support arrangement 1 and configured to be moved by the support arrangement 1.

Referring now to figure 4 of the accompanying drawings, the coil support
25 apparatus 15 comprises a support frame 17 which is mounted to the first platform 14. A spindle 18 is rotatably mounted to the support frame 17. A generally planar surface in the form of a turntable 19 is mounted to the spindle 18 and configured for rotation in unison with the spindle 18. The axis of rotation of the spindle 18 is generally perpendicular to the planar platform 14
30 that supports the coil support apparatus 15. In this embodiment, the diameter of the turntable 19 is approximately 900 centimetres.

In use, the coil support apparatus 15 supports a coil of earth tape 29 which has been hoisted up onto the platform 14 using the winch W and installed on the coil support apparatus 15. The spindle 18 extends at least partly through an aperture in the centre of the coil of earth tape 29 to retain the coil of earth tape 29 in position on the turntable 19. The coil of earth tape 29 and the turntable 19 can therefore rotate about the axis of rotation of the spindle 18 as successive sections of earth tape are unwound from the coil of earth tape 29.

Referring now to figures 5-7 of the accompanying drawings, the straightening apparatus 16 comprises a housing 20 which has a generally rectangular profile and cross section. The housing 20 is approximately 1.3 meters long, 0.6 metres high and 0.4 metres deep. A plurality of drive rollers 21, 22 and a plurality of straightening rollers 23 are rotatably mounted to the upper surface of the straightening apparatus 20, as shown in figure 5. In this embodiment, there are two pairs of spaced apart drive rollers 21, 22 and a group of five straightening rollers 23.

The distance between each of the driver rollers 21, 22 and each of the straightening rollers 23 across the width of the straightening apparatus 16 is adjustable. Adjustment levers 24 and 25 are provided on opposite sides of the straightening apparatus 16. The adjustment levers 24, 25 are configured to move the drive rollers 21, 22 and the straightening rollers 23 towards or away from one another to vary the distance between the rollers 21-23 across the width of the straightening apparatus 16.

The straightening apparatus 16 further comprises a motor 26 and a gearbox 27 which are positioned within the housing 20, beneath the rollers 21-23. The motor 26 and the gearbox 27 together provide a drive arrangement which is configured to drive at least some of the drive rollers 21, 22 and/or at least some of the straightening rollers 23 to rotate. The motor 26 and the gearbox

27 are controlled by a control unit 28 which is mounted to the housing 20 of the straightening apparatus 16.

5 The system is configured to enable a user to install an earth tape along an elongate surface, such as the inner surface of the tunnel 12. A user mounts a coil of earth tape 29 on the coil support apparatus 15 so that the spindle 18 extends at least partly through an aperture in the centre of the coil of earth tape 29, as shown in figure 8. The user unwinds a portion of the earth tape 29 and positions an end section 30 of the earth tape 29 between the straightening
10 rollers 23 and the drive rollers 21, 22. The user adjusts the spacing between the straightening rollers 23 and the drive rollers 21, 22 so that the rollers 21-23 contact opposing sides of the earth tape 29.

The user activates the straightening apparatus 16 by operating the control unit
15 28 to start the motor 26. The motor 26 drives the drive rollers 21, 22 and/or the straightening rollers 23 to rotate. The rollers 21-23 contact the outer surfaces of the earth tape 29 and the rotational force of the rollers 21-23 acting on the earth tape 29 pulls the earth tape 29 through the space between the rollers 21-23. The earth tape 29 is uncoiled as it is pulled through the rollers
20 21-23 and straightened by the straightening rollers 23 which act on opposing sides of the earth tape 29.

The straightening apparatus 16 outputs straight successive sections of earth tape which can be installed directly on an elongate surface, such as the inside
25 surface of the tunnel 12 as shown in figure 1.

The straightening apparatus 16 is configured to straighten an earth tape having a rectangular cross section with a width of up to approximately 50 millimetres and a thickness of approximately 3 millimetres. The straightening
30 apparatus 16 is also preferably configured to straighten earth tape that is specially designed for use with an embodiment of the invention.

The support arrangement 1 is configured to be locked in position within the tunnel 12 to enable a user to safely operate the straightening apparatus 16 and install the earth tape 29 at a raised position within the tunnel 12.

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The system is compact and dimensioned to fit within an enclosed space, such as a tunnel having a diameter of between 4 and 8 metres, and preferably a diameter of approximately 3 metres. The system therefore enables an earth tape to be installed in a continuous straight length along the inner surface of a
10 tunnel. This avoids the need for the earth tape to be straightened separately at a remote location and transported to a tunnel for installation.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or
15 integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

CLAIMS:

1. A system for installing an earth tape along an elongate surface within a tunnel, the system comprising:

5 a moveable support arrangement which is configured to be moved relative to the elongate surface, the support arrangement comprising at least one wheel assembly, each wheel assembly incorporating a first wheel which is configured to rotate about a first axis and a second wheel which is configured to rotate about a second axis which is not parallel to the first axis such that the first and second wheels are configured to contact an inclined surface of
10 the tunnel simultaneously to allow the support arrangement to be moved along a length of the tunnel;

a coil support apparatus which is configured to support a coil of earth tape; and

a straightening apparatus which is configured to receive successive sections of earth tape from the coil of earth tape, straighten the successive sections of earth tape and output
15 straightened sections of earth tape, wherein the coil support apparatus and the straightening apparatus are carried by the support arrangement and configured to be moved by the support arrangement relative to the elongate surface so that the straightened sections of earth tape can be installed along at least part of the elongate surface within the tunnel.

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2. The system of claim 1, wherein the coil support apparatus comprises a planar surface which supports at least part of the coil of earth tape, the planar surface being rotatable about an axis which is generally perpendicular to the planar surface.

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3. The system of claim 2, wherein the coil support apparatus comprises a spindle which extends generally perpendicularly from the planar surface, the spindle being configured to be received within an aperture positioned at the centre of the coil of earth tape.

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4. The system of any one of the preceding claims, wherein the straightening apparatus comprises at least two drive rollers which are spaced apart from one another, the drive rollers being configured to rotate and contact the successive sections of earth tape such that the rollers exert a force on the

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earth tape to uncoil the successive sections of earth tape from the coil of earth tape.

- 5 5. The system of any one of the preceding claims, wherein the straightening apparatus comprises at least two straightening rollers which are spaced apart from one another, the straightening rollers being configured to contact the successive sections of earth tape and to exert forces on the earth tape to straighten the earth tape.

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6. The system of claim 5, wherein the straightening apparatus comprises five straightening rollers, wherein three of the five straightening rollers are positioned adjacent one side of the straightening apparatus and two of the five straightening rollers are positioned adjacent an opposite side of the straightening apparatus.

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7. The system of claim 5 or claim 6, wherein the distance between each of the straightening rollers is adjustable so that the distance between the rollers can be set to match the thickness of an earth tape.

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8. The system of any one of claims 4 to 6, wherein the straightening apparatus comprises a motor which is configured to drive at least one of the rollers to exert a force on the earth tape to pull the earth tape through the straightening apparatus.

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9. The system of claim 1, wherein the system further comprises at least one further wheel assembly, the first and second wheels in each wheel assembly being configured to contact an inclined surface to moveably support the support arrangement.

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10. The system of any one of the preceding claims, wherein the system is dimensioned to fit inside and move along the inside of a tunnel having a diameter of between 4 and 8 metres.

10 11. The system of any one of the preceding claims, wherein the moveable support arrangement comprises a raised support platform which supports the coil support apparatus and the straightening apparatus in a raised position relative to the base of the moveable support arrangement.

15 12. The system of claim 11, wherein the system further comprises a hoist apparatus which is configured to hoist a coil of earth tape up and onto the raised support platform.

20 13. The system of claim 11 or claim 12, wherein the support platform is raised by between 2 and 4 metres from the base of the moveable support arrangement such that the straightening apparatus outputs straightened sections of earth tape for installation at a raised position.

14. A method of installing an earth tape along an elongate surface within a tunnel, the method comprising:

25 rotatably mounting the coil of earth tape on a coil support apparatus, the coil support apparatus being carried by a moveable support arrangement which is configured to be moved relative to the elongate surface, the support arrangement comprising at least one wheel assembly, each wheel assembly incorporating a first wheel which is configured to rotate about a first axis and a second wheel which is configured to rotate about a second axis which is not parallel to the first axis such that the first and second wheels are configured to contact an inclined surface of the tunnel simultaneously to allow the support arrangement to be moved along a length of the tunnel;

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positioning the moveable support arrangement within the tunnel;

feeding one end of the earth tape into a straightening apparatus which is carried by the support arrangement;

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activating the straightening apparatus to pull successive sections of earth tape through the straightening apparatus to straighten the successive sections of earth tape; moving the support arrangement adjacent to and along the elongate surface; and
5 installing the straightened sections of earth tape along at least part of the length of the elongate surface within the tunnel.

15. The method of claim 14, wherein the method further comprises locking the
10 support arrangement in position to install the straightened sections of earth tape along at least part of the length of the inside surface of the tunnel.

16. The method of claim 15, wherein the tunnel has a diameter of between 4 and 8
metres.

15 17. The method of claim 15 or claim 16, wherein the method further comprises moving the moveable support arrangement along the tunnel at a speed which matches the speed at which the straightened sections of earth tape are output from the straightening apparatus.

20 18. The method of any one of claims 14 to 17, wherein the straightening apparatus comprises at least two straightening rollers which are spaced apart from one another and at least two drive rollers which are spaced apart from one another and the method further comprises adjusting the distance between each of the straightening rollers and each of
25 the drive rollers such that the spacing between the rollers matches the thickness of an earth tape which is to be straightened by the straightening apparatus.