

# **CONSTRUCTION METHOD OF LAYING CABLE AND CABLE LAYING APPARATUS**

## **BACKGROUND OF THE INVENTION**

### **1. FIELD OF THE INVENTION**

This invention relates to a construction method of laying cable and a cable laying apparatus and, more particularly, to a construction method of laying cable and a cable laying apparatus for laying cable along cable laying routes in a structure.

### **2. DESCRIPTION OF THE RELATED ART**

Conventionally, a boiler room in a thermal power plant or the like requires connecting a number of distribution cable between an electric power room on the ground and a control panel or electrical machinery and apparatus mounted on the boiler room. For laying the distribution cable in distribution ducts constructed in the boiler room, two methods are employed: a method in which a drum wound with the distribution cable is lifted up onto the boiler room, and then an end of the distribution cable is sent downward from the top opening end of the distribution duct; and a method in which an end of the distribution cable is inserted into the distribution duct from the bottom opening thereof, to be drawn upward.

As disclosed in Japan Patent Laid-open No. Hei7-123554, a method in which after a looped wire is disposed in a distribution duct, an end of a distribution cable is attached to the looped wire, and the distribution cable is laid in the inside of the distribution duct through the circulating movement of the wire, is also known.

However, since the height of the aforementioned boiler room reaches some tens meters, the entire length of the distribution cable is often over 100 meters. Naturally, the drum wound with the distribution cable is heavy in

weight (400kg to 2,000Kg). It requires great effort and time in the method in which the drum is lifted up onto the boiler room. In addition, since there is not any space for placing the drum on the boiler room, allocation of a space for the drum is difficult.

In the aforementioned method in which the end of the distribution cable is drawn upward, since the drawing-up process is carried out by manpower, harsh work and the poor efficiency of work are concerned.

In the method of towing the distribution cable through the circulating movement of the wire, the wire and the distribution cable each have a twisted structure from single wires, so that receiving tension, the wire and the distribution cable each rotate in an untwining direction. Thus, it is expected that the wire and the distribution cable may be mutually entwined (especially, in the vertical direction), so that the extra provision of a separating member for preventing the wire and the distribution cable from mutually entwining is required.

Moreover, in the above method, the distribution cable cannot be conveyed forward to cross the wire for the reason of the structure for towing the distribution cable. In order to connect the distribution cable to some device or the like placed ahead of the wire, after being towed by the wire, the distribution cable must be towed by manpower from the endpoint of the wire, resulting in great effort and time.

When the distribution cable is laid for a long distance, the distribution cable is successively attached to the wires, disposed in plurality along the laying route, by manpower or other ways. In this case, a first wire, detached from the distribution cable, does not assist in conveying the distribution cable forward, so that the laying process of the distribution cable is carried out by only the next wire attached to the distribution cable. Thus, the towing of the distribution cable requires a larger force as the distribution cable approaches closer to the endpoint side of the laying route, and whereby the end of the distribution cable may be damaged. When an auxiliary laying device is arranged between wires, the tension on the distribution cable can be relived. In this point, however, other disadvantages such as a complex



formation of an apparatus and an inconvenient operation result.

## SUMMARY OF THE INVENTION

In consideration of the above conventional disadvantages, it is an object of the present invention to provide a construction method of laying cable and a cable laying apparatus, capable of conveying forward the distribution cable while avoiding the occurrence of twisting in towing a distribution cable, and reliably laying the distribution cable even for a long distance of laying the distribution cable.

In order to achieve the above object, in the present invention a band-shaped belt guided by a guide roller along a cable laying line is laid, and a driving force is applied by driving pinch rollers to circulate the belt. A simply structured cable attachment means such as a face fastener may be used for coupling the cable to the belt, in which the cable can be attached to the belt by the simple means of pressing or hooking an end of the cable against or onto the surface of the belt. In other words, in the present invention a cable laying apparatus in which the laying belt is stretched by the guide roller is provided. The cable attachment means is provided on the surface of the laying belt, and whereby the end of the distribution cable is attached to the laying belt. In addition, the laying belt is provided with a driving device and a tensioning device, whereby the laying belt runs while flexure of the belt is absorbed.

When the cable laying apparatus is structured as described above, since a guide face of the laying belt is in contact with the guide roller at all times, the belt attitude is not changed and the laying belt does not rotate although tension from the distribution cable is added to the laying belt. Therefore, the distribution cable is towed without the entwinement between the laying belt and the distribution cable.

By structuring so that the laying belt and the cable are pinched by the pinch rollers at some points on the cable laying route, even when the end of



the cable is detached from the laying belt, the cable can continue to be conveyed with the running of the laying belt. For this reason, after the end of the cable reaches an endpoint side of a cable laying route of one laying belt, the end of the cable is detached from the laying belt and the cable is sent out toward the next laying cable apparatus together with the laying belt, whereby the cable can be conveyed forward to cross the laying belt. Therefore, if the laying belts are arranged in multistage along the cable laying route, then it becomes easy to transfer the cable in succession from one laying belt to the next laying belt. Since the cable is caught and conveyed by other laying belts below the top laying belt coupling the end of the cable, the driving for the laying belts does not require a large amount of power, and additionally, it is avoided that load is partially applied to the cable.

Where a bending area is formed in the laying belt, provided that the laying belt is disposed to be caught between the guide roller and the cable, the cable can not be caught between the guide roller and laying belt, therefore the cable is smoothly detached from the laying belt. The laying belt can be twisted for disposing the laying belt in the above conditions. In this case, on condition that an opening for detaching the cable is provided on one side of the guide roller, that is an opening enabling the cable to be detached is provided in the twisting path of the laying belt around the cable, the cable can be effortlessly detached from the laying belt only by moving in the width direction of the laying belt after the cable is completely laid.

### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plane view of a cable laying apparatus according to a preferred embodiment;

Fig. 2 is a front view of the cable laying apparatus according to the preferred embodiment;

Fig. 3 is a sectional view taken along the A-A line in Fig. 1;

Fig. 4(A), Fig. 4(B) and Fig. 4(C) are block diagrams for attaching a face fastener as a cable attachment means;

Fig. 5(A) and Fig. 5(B) are external views of a driving device 34 in the cable laying apparatus 10;

Fig. 6 shows an application example of a cable attachment means when an adhering member is mounted on the entire surface of a laying belt 18;

Fig. 7 is a side elevational view of a boiler room when the cable laying apparatus 10 is applied for a boiler room of a thermal power plant;

Fig. 8 is a first application example of the construction method of laying cable;

Fig. 9 is an explanatory view showing the laying belt 18 which passes via a bending point;

Fig. 10 is a top view showing an application example of the cable laying apparatus 10; and

Fig. 11 is a front view of the application example of the cable laying apparatus 10.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)**

Specific embodiments according to the present invention will be below in detail.

The present invention attains on the basis of deliberation that the stable belt attitude in running is obtained when a belt follows guide rollers, and thereby a distribution wire can be towed with reliability.

Specifically, a construction method of laying cable according to the present invention includes the steps of: disposing a loop-shaped laying belt along a cable laying route; attaching the cable to a given point of the laying belt; and running the laying belt to lay the cable along the cable laying route. Here, a construction method may includes the steps of: disposing a plurality

of loop-shaped laying belts along the cable laying route in a longitudinal direction; detaching the cable from the first laying belt after the cable reaches an endpoint side of the first laying belt by the running of the first laying belt; sending out the detached cable again; attaching the cable to a starting point side of a second laying belt after the cable leaves the first laying belt and reaches the starting point side of the second laying belt; and the detaching step, the sending-out step and the attaching step are repeated to lay the cable completely.

Alternatively, it is possible that a loop-shaped laying belt is disposed along a cable laying route; an end of the cable is attached to a given point of the laying belt; and the laying belt runs while pinch rollers pinch the laying belt and the cable.

In addition, the end of the cable is detached from the laying belt when the end of the cable reaches an endpoint side of the cable laying route; the end of the cable sent out over the laying belt; and the cable is moved in a width direction of the laying belt, to be completely laid along the cable laying route. Here, it is advisable that a bending point is formed in the cable laying route by means of guide rollers provided along the cable laying route, and the laying belt is twisted and routed so that the laying belt is positioned between the guide roller and the cable.

A cable laying apparatus according to the present invention includes a cable attachment means provided on a loop-shaped laying belt disposed along a cable laying route; and a convey means for running the laying belt so that the cable, attached to the laying belt by the cable attachment means, is laid along the cable laying route by the running of the laying belt.

Alternatively, a cable laying apparatus can include guide rollers disposed along a cable laying route; a loop-shaped laying belt guided by the guide roller; and pinch rollers pinching the laying belt and cable, the laying belt having a cable attachment means and a convey means for running the laying belt so that the cable, attached to the laying belt by the cable attachment means, is laid along the cable laying route by the running of the laying belt.

The preferred embodiments of a construction method of laying cable and a cable laying apparatus according to the present invention will be below in detail with reference to the attached drawings.

Fig. 1 is a plane view of a cable laying apparatus according to a preferred embodiment. Fig. 2 is a front view of the above cable laying apparatus according to the preferred embodiment. And, Fig. 3 is a sectional view taken along the A-A line in Fig. 1. As shown the above drawings, the cable laying apparatus 10 is attached to an opening end side of a duct 14 of C-shaped cross-section as a C-shaped channel member which is a cable laying route and holds a distribution cable 16.

In the cable laying apparatus 10, a laying belt 18 for towing the distribution cable 16 is extended along a duct 14 by means of guide rollers 20. The guide roller 20 is adapted to have a length corresponding to a width (approximately 50mm) of the laying belt 18. End plates 22 for preventing the laying belt 18 from falling, are respectively formed at both ends of the guide roller 20. The guide rollers 20 as described above are disposed in the vertically direction, and of which one end is attached to a plate-shaped stay 24. A vise 26 is attached to a portion of the plate-shaped stay 24 below where the guide rollers 20 are attached thereto, the use of vise 26 allowing a roller unit 28, as described above, to be attached to the opening end side of the duct 14. The roller units 28 are arranged in plurality along the cable laying route to guide the laying belt 18.

The laying belt 18 is an endless belt formed of polyurethane type materials and has a plate-shaped cross-section, forming a guide face 12 on the back face side of the laying belt 18. The guide face 12 is in contact with the guide roller 20, whereby the laying belt 18 can run in a direction of arranging the roller units 28. As shown in Fig. 4, a face fastener (belt side) 30 to be a cable attachment means is adhered on the laying belt 18. The face fastener 30 is close-coupled to a face fastener (cable side) 32 provided at the end of the distribution cable 16, whereby the distribution cable 16 is attached to the laying belt 18.

In the above cable laying apparatus 10, a driving device 34 serving as

pinch rollers and a convey means for running the laying belt 18 is provided. Figs. 5 are external views of the driving device 34 of the cable laying apparatus 10. In Fig. 5(A), endless belts 36 are arranged on both sides of the laying belt 18 to position the laying belt 18 between the endless belts 36. The laying belt 18 and the distribution cable 16 are conveyed by driving the endless belts 36 with a pulley. Each side of a pair of the endless belts 36 with the laying belt 18 in between is disposed on a moving rail (not shown) provided along a thickness direction of the laying belt 18. Therefore, even when a space between the endless belts 36 is changed by sandwiching the laying belt 18 and the distribution cable 16, the convey of laying belt 18 and the distribution cable 16 can be ensured. In Fig. 5(B), a rubber made hollow balls 38 are arranged on both sides of the laying belt 18 to position the laying belt 18 between the hollow balls 38. The laying belt 18 and the distribution cable 16 are conveyed by driving the hollow balls 38. When the hollow balls 38 convey the distribution cable 16, the hollow balls 38 are deformed to follow the shape of the distribution cable 16, so that the close-contact property is increased so as to ensure the convey. Note that, the two embodiments for the driving device 34 are described, but the embodiments are not limited, therefore various forms can be available for the driving device insofar as the laying belt 18 and contribution cable 16 are conveyed properly. In the embodiments, the one driving device 34 (a plurality of driving devices may be acceptable) is disposed at a portion positioning somewhat inward from the end portion of the cable laying apparatus 10, whereby after the distribution cable 16 is completely conveyed, the end of the distribution cable 16 can be detached from the laying belt 18.

In the cable laying apparatus 10, a tensioning device 40 for detaching the slack from the running laying belt 18 as well as the above driving device 34 is provided (see Fig. 1 and Fig. 2). The tensioning device 40 is composed of a guide roller 20 and a spring 41 towing the guide roller 20, and in the embodiment, disposed at a changing direction area 42 forward of the driving device 34 on the laying belt 18.

The distribution cable 16 to be laid by the cable laying apparatus 10

structured as described hereinbefore is usually stored in a wound state on a drum 44. When the distribution cable 16 is laid, the drum 44 is placed outside the end portion of the cable laying apparatus 10, and the end of the distribution cable 16 is drawn toward the cable laying apparatus 10. The face fastener (cable side) 32 is provided at the end of the distribution cable 16 as described hereinbefore. The attachment of the end of the distribution cable 16 to the face fastener (cable side) 32 is carried out with a net type holder net 48 and a reversible rotation mechanism 46 which is provided between the distribution cable 16 and the face fastener 32, thereby even when the distribution cable 16 rotates, the rotation is absorbed and avoided transferring to the laying belt 18, and additionally, the end of the distribution cable 16 is prevented from the damage by a towing load.

Procedural steps for laying the distribution cable 16 with the cable laying apparatus 10 structured as described hereinbefore will be explained below.

The drum 44 is placed outside one side of the cable laying apparatus 10 disposed in the duct 14 which is to be laid therein with the distribution cable 16 (in the duct 14 as an object for laying). Since the face fastener (cable side) 32 has been provided in advance through the reversible rotation mechanism 46 and holder net 48 to the end of the distribution cable 16, the face fastener (cable side) 32 is fastened onto the face fastener (belt side) 30 adhered on the laying belt 18. After the end of the distribution cable 16 is attached to the laying belt 18, the driving device 34 is brought into operation to run the laying belt 18.

Running the laying belt 18, the distribution cable 16 is sent out together with the laying belt 18 along the cable laying route. The laying belt 18 runs while the guide face 12 is kept in contact with the guide rollers 20, so that the attitude stability is obtained, thereby a rotating action does not occur to the laying belt 18 itself. Therefore, the laying belt 18 and the distribution cable 16 are not mutually entwined during running, and the towing of the distribution cable 16 is properly performed. When the end of the distribution cable 16 reaches the changing direction area 42 of the cable

laying apparatus 10, the driving device 34 is stopped once. In this time, the end of the distribution cable 16, namely the position of the face fastener (cable side) 32, is between the driving device 34 and the changing direction area 42, so that the face fastener (belt side) 30 and the face fastener (cable side) 32 are separated. In this state, the driving device 34 is operated again to run the laying belt 18. Since the distribution cable 16 is caught in the driving device 34 together with the laying belt 18, even when the end of the distribution cable 16 is separated from the surface of the laying belt 18, the distribution cable 16 is moved together with the laying belt 18. Thus, the end of the distribution cable 16 is conveyed forward across the changing direction area 42, with the result that the distribution cable 16 can be connected to a control panel or electrical machinery and apparatus (not shown), provided ahead of the cable laying apparatus 10.

In the embodiment, a cable attachment means is designed as the face fastener, but the cable attachment means is not limited to the embodiment and can take various forms. Fig. 6 shows an application example of the cable attachment means when an adhering member is mounted on the entire surface of the laying belt 18. If the adhering member 50 is provided on the entire surface of the laying belt 18 as illustrated in the drawing, the distribution cable 16 can be conveyed without providing the coupling point between the laying belt 18 and the distribution cable 16. Note that, a press roller 52 is for increasing the adhesion between the distribution cable 16 and the adhering member 50, and a separating roller 54 is for increasing separating properties between the distribution cable 16 and the adhering member 50. As a result, a plurality of the distribution cables 16 can be conveyed with respect to the laying belt 18, thereby improving efficiency of work.

Fig. 7 is a side elevational view of a boiler room when the cable laying apparatus 10 is applied for a boiler room of a thermal power plant. As shown in the drawing, in the boiler room 56 of the thermal power plant, a contribution duct 58 for passing the distribution cable 16 therethrough is constructed in the inside of the exterior wall of the boiler room 56. The

cable laying apparatus 10 is placed to accompany the route of the distribution duct 58. When the cable laying route in, for example, the boiler room of the thermal power plant is long and the distribution cable 16 is laid to be divided in a branching form in the distribution duct 58, the provision of single cable laying apparatus 10 decreases efficiency. Thus, a construction method in which a plurality of the cable laying apparatuses 10 are continuously arranged along the distribution duct 58 is contrived. Fig. 8 shows a first application example of the construction method of laying cable.

In the continuous arrangement of a plurality of cable laying apparatuses 10 along the distribution duct 58 as shown in the drawing, when the end of the distribution cable 16 reaches the changing direction area 42 in the first cable laying apparatus 10A, the face fastener (cable side) 32 and the face fastener (belt side) 30 are separated by hand and the end of the distribution cable 16 is sent forward across the changing direction area 42. The end of the sent distribution cable 16 is attached to the next laying belt 18B, and the distribution cable 16 is conveyed forward with the next laying belt 18B. In this time, the distribution cable 16 is still in contact with the first laying belt 18A, so that by simultaneously operating the first laying belt 18A, the distribution cable 16 can be conveyed for a long range without increasing force of each individual driving device 34 of the cable laying apparatuses 10. Since the only end of the distribution cable 16 is not towed, load on the end of the distribution cable 16 is decreased, thereby avoiding damaging the cable film from overloading and the like. The cable laying apparatuses 10 are disposed not only at the main route of the distribution duct 58 but also at all other routes, thereby allowing the distribution cable 16 to be easily laid in the branching form.

As shown in Fig. 7, the laying belt 18 of the cable laying apparatus 10 is not always placed straight, and may be often placed along a bending portion of the distribution duct 58. For forming a bending point on the laying belt 18, the guide roller 20 is necessarily disposed in the bending area. However, when the distribution cable 16 is caught between the guide roller 20 and the laying belt 18, a convergence stress is added to the distribution

cable 16, so that it is difficult to detach the distribution cable 16 from the cable laying apparatus 10 after the completion of laying the cable. Thus, in the bending area of the laying belt 18, the distribution cable 16 requires positioning outside the bending point of the laying belt 18. Fig. 9 is an explanatory view showing the laying belt 18 which passes via the bending point. As shown in the drawing, where there are two bending points 60 and the laying belt 18 is arranged in a stepping form, the laying belt 18 is necessarily twisted at some midpoint thereof in order that the distribution cable 16 may be positioned on the outermost circumference. Provided that the laying belt 18 is twisted indiscriminately (e.g., in a spiral form), when the distribution cable 16 is removed from the other side of the plate-shaped stay 24 (see Fig. 3), the distribution cable 16 is positioned to spread across the openings for detaching, so that the laying belt 18 becomes an obstruction, resulting in the impracticability of detaching the distribution cable 16. Therefore, in twisting the laying belt 18, the laying belt 18 should be twisted not to close an opening of a direction of detaching the distribution cable 16 with directing attention to the twisting direction.

The laying belt 18 having passed through the first bending point 60 requires rotating at 180 degrees and completely reversing in order that the distribution cable 16 may not be caught between the laying belt 18 and the guide roller 20 until before reaching the next bending point 60. In this time, insofar as the twisting direction of the laying belt 18 is determined so that the surface, adhered thereon with the face fastener (belt side) 30, of the laying belt 18 is always seen from the detaching direction of the distribution cable 16, the laying belt 18 does not obstruct the detaching direction of the distribution cable 16, therefore the distribution cable 16 can be properly detached from the bending point 60. By determining the twisting direction of the laying belt 18 in the bending point 60 in the above manner, even though a plurality of the bending areas 60 are provided, the distribution cable 16 can be effortlessly detached from the cable laying apparatus 10 only by moving the distribution cable 16 in the detaching direction (in the other side of the plate-shaped stay 24).

Fig. 10 and Fig. 11 are respectively a top view and a front view showing an application example of the cable laying apparatus 10. As clear from the drawings, the ducts 14 of the up and down stages are disposed. In the laying process for the distribution cable 16 in each duct 14, the laying belt 18 is twisted at the changing direction area 42, to draw out toward the side of the duct 14. When both end portions of the laying belt 18 are drawn out toward the side of the duct 14 and the central portion of the laying belt 18 is stretched along the duct 14, the laying processes of the distribution cable 16 in the up and down ducts 14 can be simultaneously performed, resulting in the improvement of efficiency of the laying work. As shown in the drawings, a cable laying apparatus which does not have a driving source on its own but obtains a rotating speed from the running force of the belt sandwiched between the rollers, and is capable of conveying forward the distribution cable 16, sandwiched together with the laying belt 18, by the obtained rotating speed, is provided in the duct 14 of the down stage. Thereby, without changing places for setting the driving device 34 provided in the duct 14 of the up stage, the cable laying processes in the up and down stages can be performed.

In the embodiment, the guide roller 20 is used for guiding the laying belt 18, but the guide roller 20 is not limited provided that the guide face 12 of the laying belt 18 can be in contact and the laying belt 18 can be stably run. Instead of the guide roller 20, for example, a sled having ribs, for preventing the belt from falling, at both sides thereof may be applied. In the embodiment, the laying belt 18 is explained as the endless belt, but it is not limited. For example, the laying belt 18 can be wound, like yard goods, on the guide roller 20 provided at both ends of the cable laying apparatus 10 and the laying belt 18 may be moved by the rotation of the guide roller 20.

Moreover, in the embodiment, the driving device 34 serving as the convey means and the pinch rollers is used, but it is not limited. The convey means and the pinch rollers may be separately provided in the cable laying apparatus 10.

**WHAT IS CLAIMED IS:**

1. A construction method of laying cable comprising the steps of:  
disposing a loop-shaped laying belt along a cable laying route;  
attaching the cable to a given point of the laying belt; and  
running the laying belt to lay the cable along the cable laying route.
2. A construction method of laying the cable, comprising the steps of:  
disposing a plurality of loop-shaped laying belts along the cable laying route in a longitudinal direction;  
detaching the cable from the first laying belt after the cable reaches an endpoint side of the first laying belt by the running of the first laying belt;  
sending out the detached cable again; and  
attaching the cable to a starting point side of a second laying belt after the cable leaves the first laying belt and reaches the starting point side of the second laying belt, said detaching step, said sending-out step and said attaching step being repeated to lay the cable completely.
3. A construction method of laying cable comprising the steps of:  
disposing a loop-shaped laying belt along a cable laying route;  
attaching an end of the cable to a given point of the laying belt;  
running the laying belt while pinch rollers pinch the laying belt and the cable;  
detaching the end of the cable from the laying belt when the end of the cable reaches an endpoint side of the cable laying route;  
sending out the end of the cable over the laying belt; and  
moving the cable in a width direction of the laying belt, the cable being completely laid along the cable laying route.
4. The construction method of laying the cable according to claim 3, wherein a bending point is formed in the cable laying route by means of guide rollers provided along the cable laying route, and





wherein the laying belt is twisted and routed so that the laying belt is positioned between the guide roller and the cable.

5. A cable laying apparatus comprising:

a cable attachment means provided on a loop-shaped laying belt disposed along a cable laying route; and

a convey means for running the laying belt so that the cable, attached to the laying belt by said cable attachment means, is laid along the cable laying route by the running of the laying belt.

6. A cable laying apparatus comprising:

guide rollers disposed along a cable laying route;

a loop-shaped laying belt guided by the guide roller; and

pinch rollers pinching the laying belt and cable, the laying belt having a cable attachment means and a convey means for running the laying belt so that the cable, attached to the laying belt by the cable attachment means, is laid along the cable laying route by the running of the laying belt.

