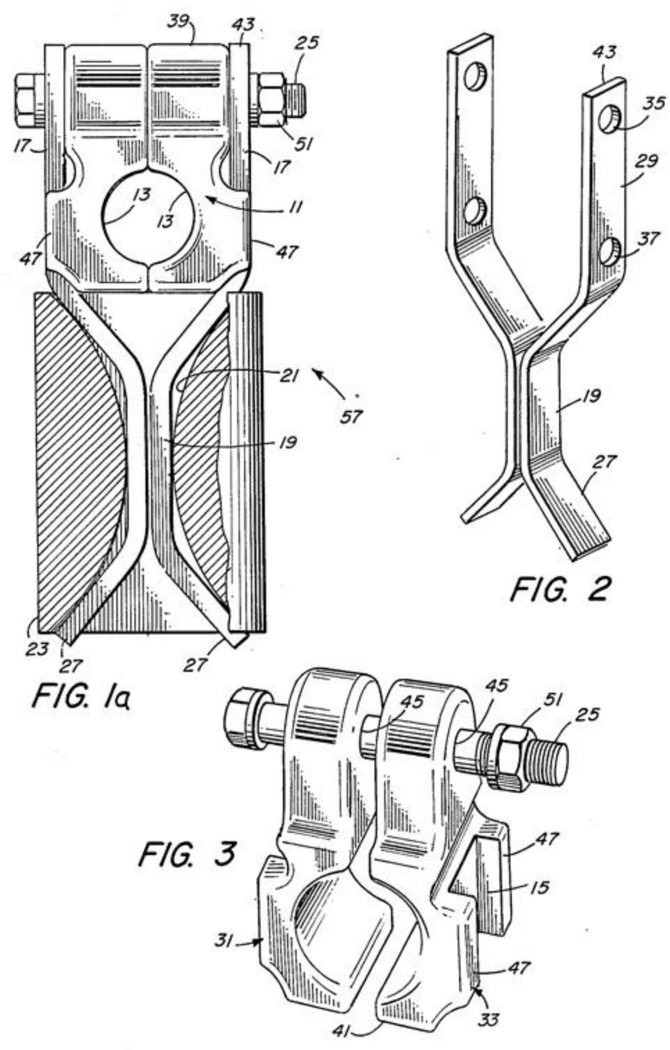
Patents

Anti-Galloping Device
US Patent 4,777,327
AR®Twister



U.S. PATENT 4,777,327
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ABSTRACT
A weight is installed in a vertical plane above a subject line. Gravity pulls the weight to an initial angle of about 140 degrees from the starting plane and thereby twists the line. The twist angle remains fixed so long as no gallop occurs. During galloping motion of the line, the initial twist is decreased as the line approaches the peak of motion and reindexed as the line leaves the peak. The line correspondingly rotates between zero degrees added twist and beyond about 140 degrees, the initial added twist angle. The rotation of the line continuously changes the profile of the air foil of the line formed by ice frozen about the line, and thereby dampens air lift and galloping of the line. The weight is attached to the line

by a grip and a pair of brackets secured to the grip at one end and fitted through a slot in the weight at opposite ends. A bolt tightens the grip between the bracket members at the one end, such that the brackets and the grip pivot about the line and the opposite ends of the brackets exert an outward force within the slot of the weight to firmly retain the weight. Alternatively, the bolt is placed between the grip and the weight such that the brackets loosely retain the weight to prevent vibration of the line. Another clamp and grip enable adjustment of the location of the center of gravity of the weight with respect to the line.

BACKGROUND OF THE INVENTION

Under the forces of wind, electrical transmission lines such as telephone cables, power lines and the like can bounce in a vertical fashion known as "galloping". The galloping poses threat to the support of the line, and the line may become tangled with neighboring lines. There are three primary categories of galloping motion in long span catenary cables, wires and conductors. The first is exhibited by a round cable that is supported by towers spaced apart at intervals of several hundred feet. Under certain weather conditions, ice tends to form along the length of the cable into the direction of the wind. As a result, the ice forms a wing protruding out of the cable. When the wind catches the aerodynamic shape of the iced cable, a vertical lift is generated and results in galloping. Hence, there is galloping due to wind force acting on the aerodynamics of an iced cable.

The second category of galloping is exhibited by out-of-round shaped lines which when twisted by wind have an aerodynamic profile without any added ice formation. One such line is a telephone cable which has a uniform figure eight cross section. When the wind blows, the figure eight shape is turned to one side and forms an effect a wing enabling air lift which results in galloping.

The third category is exhibited by steeply angled cables that cut into the wind. the vertical lift that results in galloping is due to the angle that is formed between the wind and the cable. One example of such a cable is a guy wire.

In all three cases the cable is subject to gallop or vehicle dancing motion of large amplitude if the wind force and its angle with the aerodynamics of the cable are related in a way that overcomes the inherent friction of the cable and its supports. In order to counteract a tendency toward galloping once the conditions of wind force and complementary angle are present, the damping or friction of the cable must be increased or the aerodynamics of the cable must be changed.

Most methods for increasing the damping in a transmission line or cable apply the long recognized principle that a twisted shape will not gallop. In the case of ice formed about a cable the fundamental idea behind twisting the cable so as to increase aerodynamic damping is "to confuse the ice shape" as it is distributed in a span which would otherwise gallop if the ice shape were not uniform. Only a few degrees of twist may be required to prevent galloping of the span. This principle has been successfully applied in twisted telephone cables to form a figure eight shape in its cross section which continually varies along the span and thus breaks uniformity in the ice formation along the length of the cable. More recently, the same process of twisting two conductors upon each other forming a varying figure eight cross section has been applied to overhead power conductors such as in the twisted T-2 Conductor by the Kaiser Aluminum & Chemical Company in the U.S.

The same methodology is employed in the add-on unit of Preformed Line Products, Inc., called "The Spoiler" The add-on unit is wrapped around the conductor over 30% of the span and thereby adds discontinuity to the ice formation along the conductor span.

Another method for increasing damping is the addition of a "drag damper" over 30% of the length of the span. The "drag damper" is in the shape of a small flat plate which enhances the drag force and thereby reduces the angle at which the wind acts upon an iced cable. In another type of drag damper called the "**Windamper**" (a registered trademark of Albert Richardson) the divide is attached to a single point in the conductor span below the conductor. The device blows with the wind and twists the conductor itself to create a non-uniform distribution of the ice shape along the span.

In the case of TV antenna guy cables, there is another method that has come to widespread use. Again, based on the fundamental principle of increased damping or friction, a device called the "**Sandamper**" (a registered trademark of Albert Richardson) prevents galloping of TV guy cables by a ball half filled with sand rolling on top of a portion of the cable, counteracting the vertical lift of the cable.

SUMMARY OF THE INVENTION

In the present invention, twisting of the span occurs dynamically. An initial component of twist in the span is established by gravity. A weight is initially installed "upside down" in a vertical plane above the transmission line or cable. The force of gravity pulls the weight against the predetermined torsion stiffness of the line to an initial angle of about 140 degrees from the starting plane and thereby induces a component of twist in the line. This "cocks the system". The twist angle remains fixed so long as no gallop occurs.

When gallop motion occurs as a result of ice formations along the span and a complementary wind, the vertical acceleration of the gallop motion will at first cause the weight to complement the initial component of twist. As the line approaches the peak of gallop motion, a cancellation of the twist occurs, and a reinduction of the twist occurs thereafter. The weight rotates the line between about 180 degrees and about zero degrees of added twist. The ice shape is correspondingly twisted along the span of the line in two opposite directions causing a change in air foil profile which dampens the effect of the wind acting on the twisted line. The ice shape twists between faces of opposite sides of its profile and hence provides greater dampening than in prior art devices.

In a preferred embodiment, the weight is attached to the line by a grip and a clamp means. The grip is engageable with the circumference of the line and has an axis along the line. The clamp locates the center of gravity of the weight at a point spaced from the axis such that gravity pulls the weight downward to induce a component of twist in the line. The clamp comprises a pair of members fitted to opposite sides of the grip at one end and fitted through a slot through the center of the weight at an opposite end. The opposite ends of the bracket member are outwardly angled to form a combined width which is larger than the width of the slot. The individual width of each opposite end, however, is smaller than the width of the slot for ease of assembly. A bolt pulls the bracket members against the grip to tighten the latter about the line. The same bolt holds the bracket members together and their combined shape retains the bracket members within the slot of the weight to support the weight. Further, where the bolt is connected to the end of the clamp away from the weight, the bracket members and the grip pivot about the line during tightening of the bolt such that the opposite ends of the bracket members exert an outward force within the slot means of the weight and thereby firmly retain the weight. Slots in the opposite sides of the clamping means guide the bracket members from the bolt to the slot of the weight means and prevent rotation of the brackets about the bolt.

It is preferred that the weight be connected to and twist the line at about a one third point in the span of the line.

Another weight and grip are mounted together by a bolt which enables the weight to pivot toward and away from the line to adjust the location of the weight's center of gravity with respect to the line. With such an adjustment an added twist to the line between about 90 degrees and about 160 degrees can be easily obtained at various positions in the span of the line.

In addition to damping galloping of transmission lines, the weight assembly of the present invention may be used to dampen vibration and other vertical movement in guy cables and overhead lines in general. In one such application the weight is allowed to rattle on the brackets. To that end the bolt is positioned between the grip and the weight such that the opposite ends of the bracket members pivot toward each other and loosely retain the weight. The ends of the slot through the weight are curved to fit that portion of the brackets which may make contact with the weight during rattling. The loosely retained weight responds in opposite to movement of the guy line which is axial or transverse to the weight. This assembly of the apparatus is attached to the guy line in pairs at about 6 to about 25 feet away from each end of the span with about one foot between pair members. Each pair is attached above the line with members of respective pairs to opposite sides of the line such that a "V" shape of about 90 degrees is formed by each pair.