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Brokaw

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[54] **VIBRATION DAMPER FOR ELONGATE MEMBERS**

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[52] **U.S. Cl.** .... **188/1 B,** 174/42, 343/904, 343/DIG. 1

[51] **Int. Cl.** **F16f 7/12**

[58] **Field of Search** .... 174/42, 93; 52/147, 148; 188/1 B; 267/136, 141; 343/836, 904, DIG. 1; 248/358 R

[56] **References Cited**

UNITED STATES PATENTS

705,073	7/1902	Grover	174/42
866,645	9/1907	Hagen	174/42
1,885,504	11/1932	Austin	174/42
2,889,011	6/1959	Weaver	174/42 X
2,969,416	1/1961	McGavern	174/42
3,051,278	8/1962	Smythe	52/147
3,173,519	3/1965	Sullivan	52/147
3,246,073	4/1966	Bouche et al.	174/42
3,268,654	8/1966	Morrison et al.	174/93 UX
3,553,345	1/1971	Edwards	174/42

FOREIGN PATENTS OR APPLICATIONS

1,159,536	12/1963	Germany	174/93
723,457	2/1955	Great Britain	174/93

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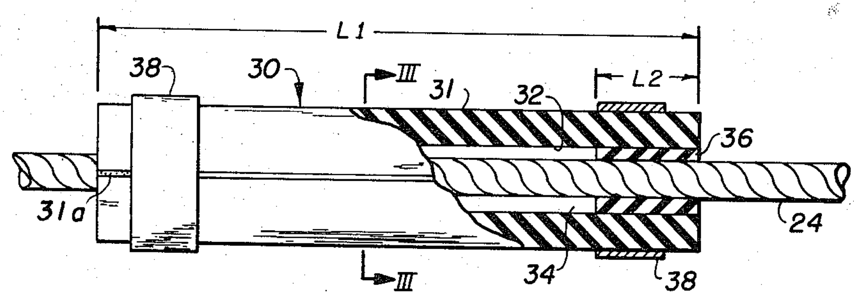
[57] **ABSTRACT**

A vibration damper for reducing vibration of an elongate member under tension, such as a cable utilizing a sleeve member clamped around the cable at both ends only, in a manner to be free to rock on the cable during vibration to suppress oscillations by shifting the natural resonant frequency of the vibrating cable.

5 Claims, 4 Drawing Figures



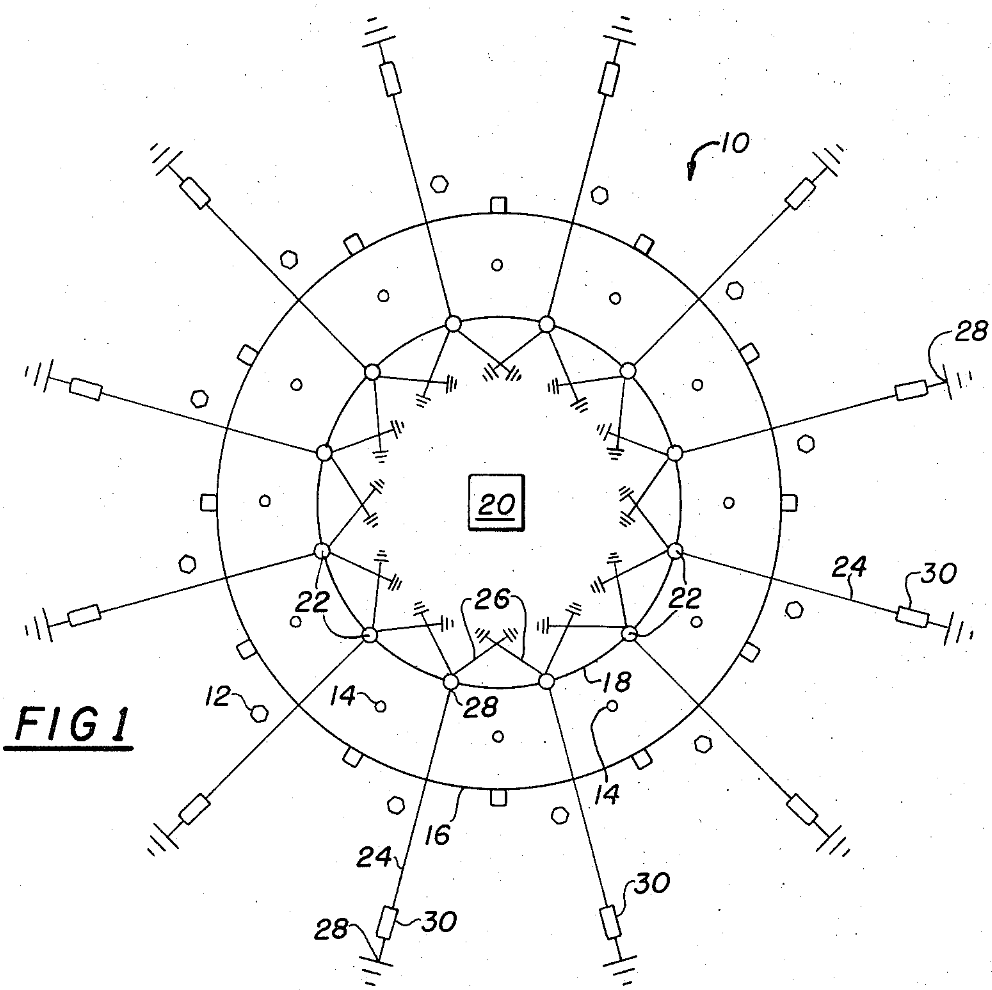


FIG 1

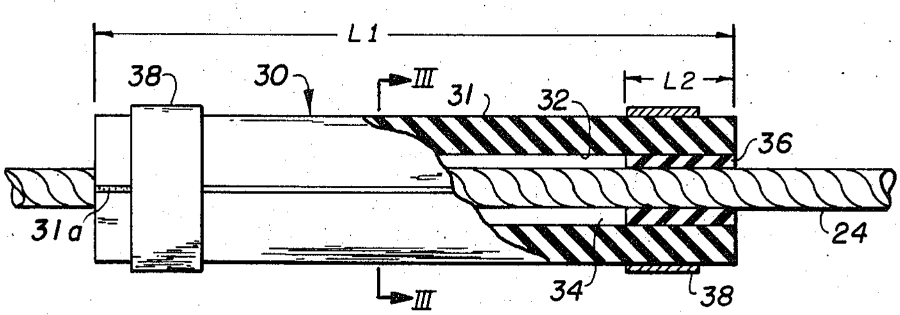


FIG. 2

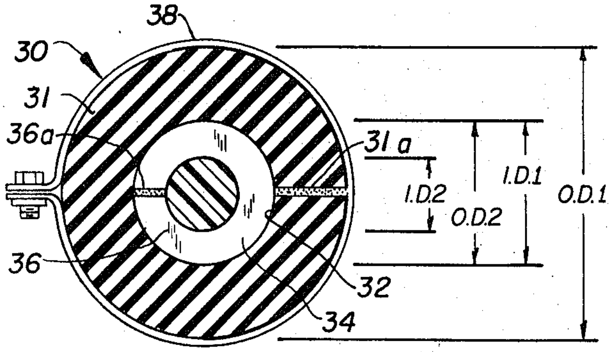


FIG. 3

DAMPER DIMENSIONS

FIBERGLASS CABLE DIA.	INSERT			SLEEVE BODY			
	I.D.2	O.D.2	L2	I.D.1	O.D.1	L1	WALL
1/4"	.250"	.375"	1.25"	.400"	1.00"	8.00"	.33"
3/8"	.375"	.563"	2.0"	.625"	1.625"	12.00"	.50"
1/2"	.500"	.812"	2.5"	.812"	2.13"	15.50"	.659"
5/8"	.625"	1.00"	3.0"	1.00"	2.625"	18.75"	.812"
3/4"	.750"	1.125"	3.75"	1.25"	3.25"	24.00"	1.00"
1"	1.00"	1.4375"	4.0"	1.4375"	3.75"	27.50"	1.156"
1 1/4"	1.25"	1.875"	6.625"	2.0875"	5.4125"	40.00"	2.66"

FIG. 4

VIBRATION DAMPER FOR ELONGATE MEMBERS

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND FOR THE INVENTION

It is a common occurrence to hear wind "whistling" through telephone and power lines. Actually, not only is sound generated by the wind, but also because of the vibration of the cable or wire at its resonant frequency. Contrary to common understanding, a cable does not vibrate back and forth from the force of the wind, but instead, the cable vibrates at right angles to the direction of the wind due to the Bernoullian phenomena. This means that the wind against a horizontal cable, for example, will produce vertical oscillations of the cable. These phenomena also apply to vertical cables with oscillations occurring at right angles to the wind.

The same conditions exist in antenna cables, and the guy cables used on antenna towers. The vibration problem becomes more severe when fiberglass cables are used to guy antenna structures in an electromagnetic environment. For example, fiberglass guy cables can be excited in even a 2-knot wind, with an amplitude of better than one-fourth inch.

Oscillations of the cable itself may not be serious, however the vibration causes wear and separation at the end fittings, clevises, and other metal components. Furthermore, this vibration, if unchecked, can be transmitted to other parts of the antenna system causing additional deterioration requiring expensive maintenance. For example, failure of only one guy cable in a Wullenweber receiver antenna array, can, and has, caused a progressive collapse of a large portion of the array amounting to over a million dollars in damage.

Several types of vibration dampers have been used in cables of this type. A metal "Stockbridge" damper has been used for horizontal transmission lines; however, it has been found in practice that the metal parts damage the cable when applied, and movements of the damper during use develop further cuts to degrade the cable. Furthermore, a metal damper has limited utility as it cannot be used in the vicinity of an electromagnetic field.

Another type of vibration damper for transmission lines is shown in U.S. Pat. No. 3,246,073. This damper consisted of a hard rubber outer sleeve having a soft sponge-rubber core resiliently engaging the transmission line for the entire length of the damper. In this type of damper, as the line vibrates, the soft rubber core alternately compresses and expands radially and the energy by the soft rubber core is converted to heat which is dissipated by the damper.

SUMMARY OF THE INVENTION

The novel damper achieves the novel results by detuning the vibrating cable, as distinguished from absorbing the vibrating energy and dissipating the heat as in the prior art reference. This novel approach as to vibrating cables follows the same laws as the vibration of a violin string. Oscillation produces a series of standing waves, consisting of alternate nodes and antinodes; depending on the tension on the string or cable, as well as the length. Holding the violin string tightly against the fingerboard produces a new tone; but pressing softly without touching the fingerboard produces a "damped" tone.

The novel cable damper of this invention has a similar effect. If the damper is firmly clamped to the cable throughout its length, as in the prior art dampers, it would tend to act as a new pivot point about which the cable would vibrate. Contact of the damper with the cable throughout the length of the damper enables the vibration to pass through the damper without effective damping.

However, in the instant invention damper the outer sleeve body of the damper is mounted to the cable in spaced relation, supported at only the ends of the body by clamps or the like to make a firm connection to the cable. In the preferred embodiment this firm connection is through spaced rubber inserts positioned between the cable and the outer sleeve member at only its ends. The invention damper when placed near an antinode point will tend to rock and lag the natural resonant frequency of the cable, and by being out of phase will detune the vibrating cable.

In practice a damping factor exceeding 50 to 1 has been attained, and by careful adjustment of the damper on the cable can stop all oscillations. To obtain the maximum damping, the invention damper should be attached to the cable at an antinode point. Damping at the first antinode point from one of the anchored ends of the cable will suppress the primary resonant frequency of the cable. However, since there are secondary frequencies, it has been found desirable to mount the damper near the second antinode point, where both fundamental and harmonics may be suppressed.

In the preferred embodiment, the outer damper body is shown as fabricated of rubber for use in guy lines located in an electromagnetic field, however, where such an environment is not involved, the outer sleeve body can be constructed of other materials, such as galvanized iron.

STATEMENT OF THE OBJECTS OF THE INVENTION

A principal purpose of this invention is to provide a vibration damper for cables or the like having a superior damping efficiency.

Another important purpose of the invention is to provide a vibration damper which detunes the vibration in a cable by an out-of-phase rocking action on the cable.

Still another object is to provide a vibration damper which can be fabricated of metallic or non-metallic material, the latter for use in an installation having an electromagnetic field.

Another important object is to provide a vibration damper which can be mounted on a cable or the like at any angular orientation to suppress oscillations about its axis.

Still other objects are to provide a vibration damper which is inexpensive and simple in construction; that is readily installed and adjusted on the cable in situ; and which will not damage the cable to which it is attached.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of a Wullenweber receiver antenna array, which is only one example of an installation on which the invention damper can be employed.

FIG. 2 is an enlarged, partially in section, side elevation view of one version of the invention damper suitable for installation on a guy cable in the antenna array of FIG. 1.

FIG. 3 is a cross-section view of the damper, taken along line III—III of FIG. 2.

FIG. 4 is a table showing the various dimensions of the components of the invention damper for accommdating different diameters of the fiberglass guy lines in the antenna array of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing there is shown in FIG. 1 a top plan view of a Wullenweber antenna receiver array **10**, being illustrative only of one type of installation on which the invention damper can be used. As illustrated, the Wullenweber array comprises generally concentric rings of high band and low band antennas **12** and **14**, respectively, and interposed therebetween concentric high band and low band screens **16** and **18**, respectively, all disposed about a centrally located building **20** housing the receiver components.

The typical Wullenweber array is about one thousand feet in diameter. Low band screen **18** is supported by spaced wooden telephone poles **22** about 95 feet high, the bases of which rest on concrete pads to prevent rotting. Poles are supported in a vertical position solely by a set of outer guy cables **24** and a set of inner guy cables **26**. Because of the electromagnetic environment it is necessary to construct outer guy cables **24** of fiberglass, whereas inner guy cables **26** can be constructed of the conventional steel cables.

Vibration is a serious problem in the Wullenweber arrangement because fiberglass cables **24** can be excited to oscillate in even a 2-knot wind with an amplitude of better than one-quarter inch, which is far greater than occurs in steel cables. Mostly, these fiberglass cables are all located in the electromagnetic field.

Oscillations of fiberglass cables may not seriously affect the cable per se, but the wear and deterioration through fatigue can readily occur at the end fittings, clevises, and other metal parts employed at the anchor points **28** at both ends of the cable. In addition, such vibration, if unchecked can be "telegraphed" to other parts of the array, causing additional deterioration requiring expensive maintenance. It has been found in practice that failure of only one outer cable **24** can cause the progressive collapse of a large portion of not only the low band screen **18**, but the adjacent portions of the array, resulting in a catastrophe in the costly installation as well as loss of critical communication capability.

It has been found that by installing the invention damper **30** on guy cables **24** at an optimum antinode point, a damping factor exceeding 50 to 1 can be achieved, and by careful adjustment in the location of the damper essentially all vibration can be stopped. It should be noted that all cables in an array of the same length should be provided with the dampers. Although the inner set of guy lines **26**, which can be made of steel wire being outside of the magnetic field, do not exhibit the magnitude of vibration found in fiberglass guy cables, such steel cables can likewise benefit from use of the invention damper. However, in such a use being outside of the magnetic field, the damper need not be made of a non-magnetic material and can be made of galvanized iron or the like without affecting the damping characteristics.

As shown in FIGS. **2** and **3**, vibration damper **30** is designed specifically for use on fiberglass cables **24** in the antenna array in FIG. **1**. Vibration damper **30** comprises an outer sleeve body **31** made of a suitable, nonmetallic material, such as neoprene rubber. One type of material that has been found particularly suitable in the above application because of its weather resistant properties is an Ethylene Propylene Rubber (EPR). Where the vibration damper is used on high power transmission lines, a material such as silicone rubber is more suitable to withstand the much higher temperature environment, and as no magnetic field is involved, outer body **31** could be made of other material, such as galvanized iron.

Outer sleeve **31** preferably has a concentric configuration with respect to cable **24**, and is provided with a core opening **32**. Core opening **32** has a diameter greater than the diameter of the cable to provide a space **34** therebetween for an important purpose later to be described. Outer sleeve body **31** is secured to cable **24** only at its ends by means of a pair of spaced tubular rubber inserts **36**, which as a manufacturing expediency in this version of the damper are best made as separate parts, although the inserts could be molded integrally with the outer rubber sleeve body if desired.

Tubular inserts **36** are fabricated to fit snugly in both ends of core opening **32** and over cable **24**. A pair of hose clamps **38** is provided one for each end of the damper to firmly secure sleeve body **31** to the cable through inserts **36**.

Both sleeve body **31** and inserts **36** are longitudinally split along one side, **31**a and **36**a, respectively, to enable the respective parts to be laterally mounted to an installed cable. Where sleeve body **31** is made of metal, it can be fabricated in two halves and secured in assembled position by clamps **38**.

The various physical characteristics of the invention damper **30** illustrated in FIGS. **2** and **3**, such as the length, and inner and outer diameters of both outer sleeve **31** and tubular inserts **36**, for different sizes of fiberglass cables are best shown in the table of FIG. **4**, which data have been derived empirically. The dimensions noted have been adjusted slightly in some instances as a manufacturing expedient to enable the use of standard off-the-shelf molding tooling. In those installations where outer sleeve **31** is fabricated of metal the dimensions will be smaller due to the greater weight factor.

OPERATION

The component parts of the damper are taken to the installation site and the sleeve **31** and inserts **36** are successively installed on each cable by spreading apart the split sides. Each insert **36** is then telescopically inserted in the respective ends of the sleeve and clamps **38** are temporarily tightened sufficiently to enable the assembled damper to be slid along the cable in the search to find its optimum damping location.

The amplitude of vibration of the cable is greatest at the antinodes, and therefore this is the appropriate position on the cable to secure the damper. Thus, before initially mounting the damper, with the cable vibrating freely in a mild wind, the first and second node points from the lower cable anchor point should be observed and noted. Damping at the first antinode, or half the distance to the first node, will suppress the primary resonant frequency of the cable.

However, to account for secondary frequencies, it has been found that optimum damping is achieved by locating damper **30** near the center of the second antinode, where both fundamental and other frequencies may be suppressed. If some vibration still persists, it may be necessary to adjust slightly the location of the damper, shifting in either direction. The optimum location is determined by the installer grasping the cable on both sides of the damper and noting the direction of improvement. The damper is then moved, 1 inch at a time, until the optimum point is reached and the cable stops oscillation. Any subsequent retensioning of the cable may require a readjustment of the damper to achieve the best damping results.

With the optimum location of the damper thus determined, clamps **38** can be adequately tightened over both ends of sleeve **31.** Slit **31***a* in the sleeve body, having been oriented downwardly, can be suitably cemented closed as can be slits **36***a* in the inserts. It is preferable that the parts not be cemented to the cable to permit subsequent adjustment in the location of the damper when necessary.

It is preferable that the invention damper be secured at the vicinity of the selected antinode point through the "soft" connection afforded by inserts **36** to avoid establishing a new node, which would occur if the connection were rigid. As the inner diameter of the intermediate portion of the main body of the sleeve is spaced circumferentially from the cable, it tends to rock out of phase and to lag the natural resonant frequency of the cable, thereby suppressing the tendency of the cable to oscillate at its resonant frequency. In other words, when the wave action in the cable drives the one end of the damper up, the rocking action drives the other end of the damper downward in opposition to the wave. The returning wave reverses the rocking action in opposition to the traveling wave. Actual tests of the invention in practice have disclosed that the damping factor exceeds 50 to 1, as compared to present day techniques of a factor of 10 to 1, and by careful adjustment, all oscillations are eliminated. As a practical matter, all cables of the same length in an array must be damped, otherwise there will be some "telegraphing" from undamped cables.

This spaced coaxial type of damper provides improved vibration damping by suppressing the wave action through the out-of-phase rocking action of the damper, rather than attempting to absorb the vibration by use of the prior art sponge rugger core which allows the wave action to pass through the damper. The novel damper can be installed on a cable or the like at any angular orientation between the horizontal and vertical, and be readily adjusted in position, if required, by retensioning of the cable. The damper can be constructed of rubber to be utilized in an electromagnetic field without influencing said field; and mounted on a nonmetallic cable without damage or deterioration to the cable. When fabricated of rubber, the damper may be painted with a coating of white synthetic rubber composition to minimize deterioration caused by the sun.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. The combination of an elongate member under tension subject to vibration and a damper for detuning said member comprising:

an outer sleeve of selected material having a predetermined length and weight depending on the physical characteristics of said elongate member;

said outer sleeve encircling the elongate member and having a core opening of a diameter substantially larger than the elongate member to prevent physical contact with the elongate member during vibration;

means made of resilient material concentrically disposed between each end of the outer sleeve and the elongate member and extending for a minor portion of the length of the elongate member;

means encircling and clamping only the ends of the outer sleeve and the resilient means to the elongate member approximately at a selected antinode point;

a substantial intermediate portion of the core opening of the outer sleeve remaining free of, and spaced from, the elongate member;

whereby said outer sleeve will rock end-to-end with respect to the elongate member in an out-of-phase relation to the oscillation of the elongate member, with the vibrating wave travelling through the core opening of the outer sleeve in the space between said resilient means instead of through the outer sleeve.

2. The combination of claim **1** wherein said elongate member is a guy cable, and the outer sleeve is constructed of resilient material.

3. The combination of claim **2** wherein the length of the outer sleeve is in the order of approximately 32 times larger than the diameter of the guy cable to which it is attached.

4. The combination of claim **2** wherein said resilient means is an inner sleeve insert constructed of a softer material than the outer sleeve.

5. The damper of claim **1** wherein said resilient means comprises a pair of tubular inserts positioned to contact the outer sleeve and the member only at both ends of the outer sleeve.

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