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VIBRATION DAMPING CONSTRUCTION FOR LONG POLE ARMS

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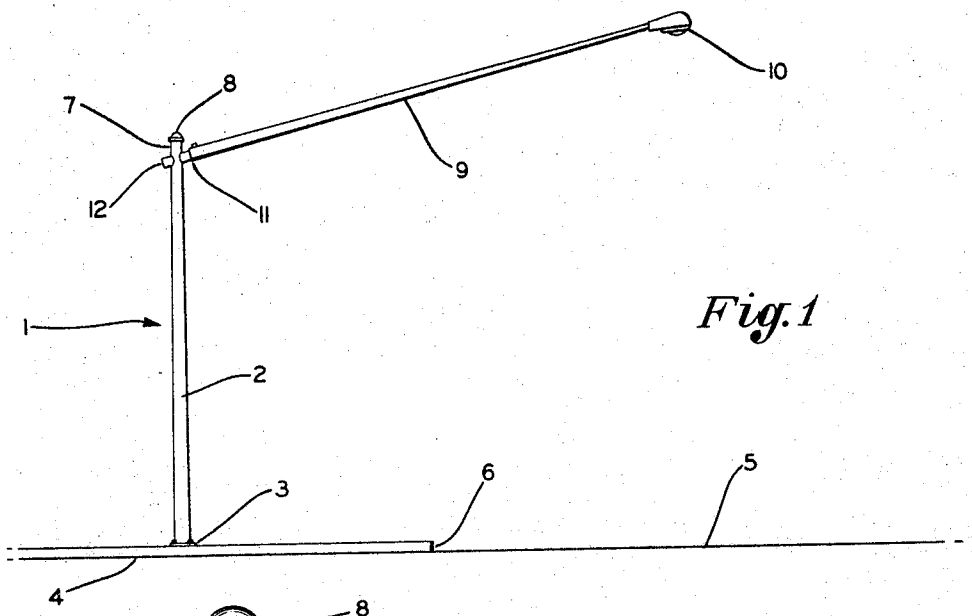


Fig. 1

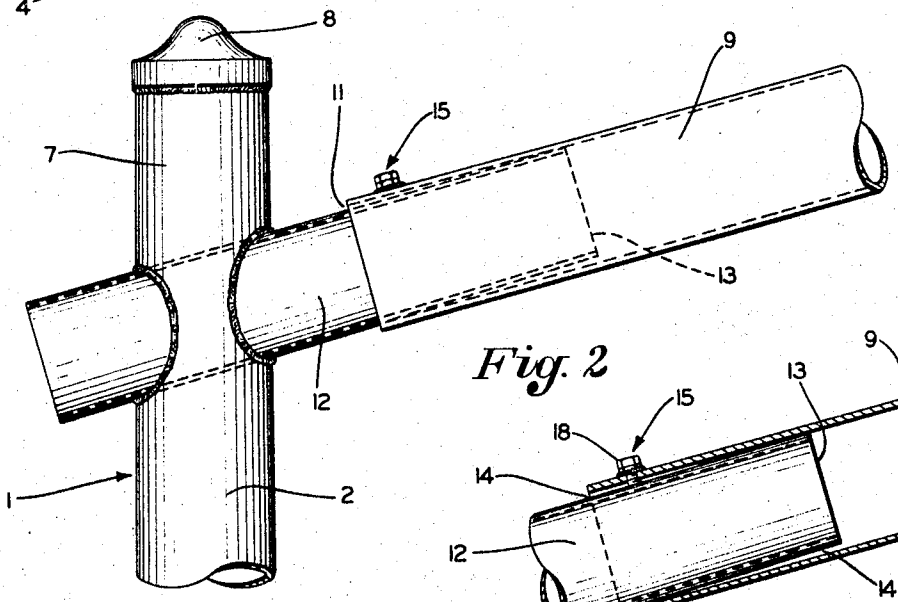


Fig. 2

Fig. 3

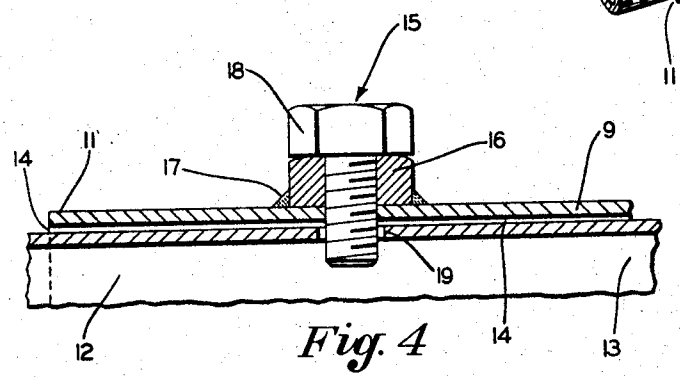


Fig. 4

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VIBRATION DAMPING CONSTRUCTION FOR LONG POLE ARMS

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ABSTRACT OF THE DISCLOSURE

A pole, being preferably formed of the tapered tubular metal shape, mounted at its base and having an elongated arm mounted on and extending from the upper end of the pole. The arm includes a first relatively short portion mounted on the upper end of the pole and extending outwardly and upwardly therefrom, and a second portion telescopically mounted over the first portion. The telescopic mounting of the second portion of the arm over the first portion of the arm comprises a loose fit to provide a loose, nonrigid joint between the first and second portions, and the outer end of the second portion being adapted to receive a light fixture or similar member.

The invention relates to highway or street lighting poles and the like; and more particularly to a mounting construction and assembly of a long pole arm or arms on a pole, with any such arm extending laterally or upwardly and laterally from one side of the pole, and which mounting construction acts to damp vibration of such pole, arm or assembly to such degree that it is not destructive.

Recent changes in requirements for locating roadway lighting poles, such as poles located along limited access highways, involve locating the lighting poles as far away as possible from traffic lanes. This reduces the likelihood of injury or damage to motorists or the poles. Such poles may be 40 or more feet in height from the pole foundation to the arm mounting location. The arm may extend generally laterally of the pole over the highway for a distance which may be approximately 40' from the pole to the lighting fixture or luminaire mounted on the end of the arm.

The poles and arms of such assemblies each may be constructed as tapered tubular metal members which are quite slender in comparison to their height or length. Such long pole arms and the lighting fixtures thereon are subject to vibration or oscillation; and such vibration may have considerable amplitude at the free or fixture end of the arm.

Continued vibration such as may be caused by winds may result in destruction of the assembly or of the luminaire mounted at the end of the arm. Vibration difficulties also have been encountered in suspending large signs from poles at automobile service stations. Some solution to these vibration problems has been sought in the art for many years.

Rubber mountings, spring loading, weight mountings, etc., of various kinds and at various locations have been tried without positive success in attempts to eliminate, reduce or compensate for vibration and violent wind flutter motion of arms or signs suspended from arms.

We have tested large highway lighting poles of the character described to determine their tendency to oscillate. Such poles have been observed to be susceptible to vibration. The tests on a lighting pole structure having a lateral arm of the character indicated, and having a good tight mounting of the arm on the pole, and also

having a lighting fixture at the end of the arm, indicate that destructive damage to the structure may occur from induced vibration. This may occur with various pole sizes, arm sizes, and wall thicknesses.

That is to say, continued induced vibration of a pole assembly structure including a pole, an arm and a lighting fixture or similar member at the end of the arm, may reach proportions or amplitudes such as to cause destruction of the structure. If the vibration is wind-induced, the amount or amplitude of vibration depends among other factors upon wind direction and velocity.

We have discovered, if a loose or "sloppy" joint is introduced in the arm of such a pole structure adjacent the location where the arm is mounted on the pole, that the natural tendency of the structure to self-damp reduces or eliminates the susceptibility of the structure to be injured by induced vibration. This result is not contrary to known principles that when vibration or oscillation of a structure gradually diminishes, depending on the rate of diminishing, the structure is less susceptible to induced vibration. Thus, our discoveries have resulted in determining that a pole structure having a sloppy joint at the indicated location is not subject to destructive vibration.

Accordingly, objectives of the invention are to provide a new pole and lighting fixture or sign supporting arm structure which eliminates or reduces induced vibration of the structure to such degree as to avoid destruction of the structure or parts thereof, or of adjacent objects which may be struck by the fall or collapse of the pole structure or parts thereof; to provide a new pole and arm structure and arrangement which controls vibration that may be induced in the structure so as to prevent destructive vibration or so as to reduce the amplitude of induced vibration to a non-destructive degree; to provide a new pole and arm structure and arrangement which breaks down or damps the vibration pattern, either by energy absorption through friction, or by interrupting the regularity of the pattern without energy absorption, or both; and to provide a new pole and arm structure which eliminates difficulties with which the art has been plagued, achieves the stated objectives simply effectively and inexpensively, and solves longstanding problems in the art.

These and other objects and advantages apparent from the following description may be obtained, the stated results achieved, and the described difficulties overcome by the structures, devices, elements, arrangements, parts and combinations, which comprise the present invention, the nature of which is set forth in the following general statement, a preferred embodiment of which—illustrative of the best mode in which applicants have contemplated applying the principles—is set forth in the following description and shown in the drawings, and which are particularly and distinctly pointed out and set forth in the appended claims.

The nature of the improved pole structure may be stated generally as including a pole having upper and lower ends and preferably being formed of metal and having a tapered tubular shape; an elongated arm having inner and outer ends preferably also formed of metal and having a tubular shape; means mounting the arm at its inner end on the upper end of the pole to extend laterally, preferably laterally and upwardly from the pole; said mounting means including a mounting member fixed to the pole and extending laterally therefrom and having a free end; a loose joint between said free end and the inner end of the arm, said loose joint being located adjacent the upper end of the pole; and a member such as a light fixture or sign mounted on or suspended by said arm.

By way of example, an embodiment of the improved construction is shown in the accompanying drawing forming part hereof, in which:

FIGURE 1 is a fragmentary side elevation of a pole mounted adjacent, but spaced a considerable distance from, a highway traffic lane, having a long arm mounted on and extending laterally and upwardly from the top end of the pole, and having a lighting fixture mounted on the outer end of the arm above the traffic lane;

FIG. 2 is an enlarged view of the upper end of the pole shown in FIG. 1;

FIG. 3 is a view similar to a part of FIG. 2 showing one portion of the arm in section; and

FIG. 4 is an enlarged sectional view of a portion of FIG. 3.

Similar numerals refer to similar parts throughout the drawing.

An improved pole structure is indicated generally at **1** and includes a pole **2**, the lower end of which is mounted on a base **3** on a suitable foundation **4** spaced a considerable distance from a traffic lane located at **5**, one edge of which may be defined by a curb **6**. For increased traffic safety, it is desirable to locate the pole **2** a considerable distance away from the curb **6**, as shown.

The pole **2** may have any desired height or size. For example, the pole may be 30 feet long and tapered with an 18 inch base and a 13.8 inch diameter at its top **7** which may be closed by a cap **8**. The tapered tubular wall may have such thickness as is required for the pole to support the applied load. The height of the pole, however, may vary considerably. It may be as tall as 40 or more feet in length with various degrees of taper and various base sizes depending upon the load and character of load which the pole must carry or support.

A lighting fixture mounting arm **9** is mounted on the top end **7** of pole **2** and arm **9** in general may have a length of say up to 40 feet or more, or from 30 to 50 feet, from the pole to the location of the lighting fixture or luminaire **10** mounted on the outer end of arm **9**. Again, the arm **9** may be a tapered tubular metal member having the desired degree of taper, diameter at the larger end of the arm, and required wall thickness.

In accordance with the invention, arm **9** terminates at **11** at its larger tapered end quite close to the upper end **7** of pole **2**, and is telescoped over the projecting end of a tubular member **12** extending at the desired angle from the upper end **7** of pole **2** and mounted on and fixed to the pole.

A desired amount of overlap between the telescoped end **11** of arm **9** and the outer end **13** of member **12** is provided as indicated in FIGS. 2, 3 and 4.

In accordance with the invention, the outer diameter of the end **13** of member **12** is somewhat smaller than the inner diameter of the overlapped portion of the end **11** of arm **9** at any section of the telescoped tapered members, so as to provide clearance as indicated at **14** in FIGS. 3 and 4.

Any desired means **15** may be used to secure the telescoped end **11** of arm **9** to the outer end **13** of member **12**. The securing means **15** may comprise a nut **16** secured by welding at **17** (FIG. 4) to arm **9**, and a bolt **18** threaded through nut **16** and extending inside arm **9** and also extending with clearance through an enlarged aperture **19** in the outer end **13** of member **12**. Thus, arm **9** is loosely secured to member **12** by the loose engagement between bolt **18** in the larger aperture **19**, and arm **9** also is loosely telescoped over member **12**, as indicated by the clearance **14** described.

This loose telescoping and securing forms what is termed herein as a "loose" or "sloppy" joint, which is one of the characterizing concepts of the invention. Tests on joints with various degrees of tightness or looseness have been made. These have included examples where the clearance **14** amounted to 0.070" difference in diameter between the outer diameter of member **12** and the inner diameter of member **9**, and also where the clearance **14** amounted to 0.140" difference in diameter.

When the loose joint is located close to the pole as indicated in the drawing, the self-damping of vibration occurs with either degree of looseness. The looser joint with the 0.140" diameter difference is preferable. The exact amount of diameter difference is not critical and may vary depending on the diameters involved, length of overlap, etc. The critical aspect is that some looseness be provided.

With such a loose joint so located, objectionable induced vibration, such as wind-induced vibration, of a structure of the character described has been eliminated or reduced to such amplitude as to be non-destructive of the pole structure.

The loose joint indicated has a damping effect upon induced vibration so as to interrupt the regularity of the oscillatory pattern and so as to introduce friction between surfaces of the arm **9** and member **12** which rub on one another, creating heat, thus providing energy absorption which assists in breaking down the vibration pattern.

In this manner, the amplitude of vibration is reduced to a minimum so that there is no destruction from induced vibration of the pole structure or parts thereof.

The concepts of the invention may be incorporated in various types and kinds of pole structures having arms extending laterally therefrom whether the arm supports a light fixture or a sigh or other object. The height, diameter, taper, wall thickness, etc., of the pole and arm are designed to have the desired values and combination of values to support the load and, with the loose joint introduced in the arm immediately adjacent the location where the arm mounting member is fixed to the upper end of the pole, destructive vibration is eliminated.

The effect of the loose or sloppy joint provided by the clearance **14** may be likened to what happens with a vibrating spring having a loose joint. In such an arrangement, part of the spring tends to vibrate at one frequency when the joint is tight, and may vibrate at a different frequency with a different phase relation when the joint is loose.

Another illustration of the general nature of the effect produced by the concept of the invention, is that of a musical instrument wherein there is a loose portion that begins to clatter which destroys the normal instrument sound. Analogously, a pole structure incorporating the concepts of the invention breaks down or interrupts the vibration pattern of induced vibration so that destructive vibration does not occur.

The new pole structure which reduces or eliminates vibration induced in the structure has been described with particular reference at times to wind-induced vibration. However, a pole structure may be subject to vibration caused or induced by an energy source other than wind. For example, pole structures mounted on bridges may have vibration imparted thereto from motion of the bridge. Similarly, a pole structure may be caused to vibrate from energy imparted thereto by highway traffic or the like. Accordingly, the vibration controlled by the improved structure may be vibration caused by or induced from any source of energy.

The weight of an arm and of a lighting fixture or sign, etc., at the end of or supported on the arm, and the length of the arm between the free end of the arm and sloppy joint, determine the mass involved and the effective lever arm support of such mass. If the mass and lever arm are large, then the joint is effective to damp induced vibration. As these values are reduced, the damping effectiveness is reduced. Thus, normally the location of the sloppy joint deirably is in the arm mounting immediately adjacent the pole.

Vibration damping effectiveness involves many factors, including among others, mass of arm and fixture or sign load and the like supported by the arm, effective lever arm length at which the mass acts with respect to the

location of the sloppy joint, the diameter difference or clearance between the telescoped parts at the sloppy joint, the diameter of the arm at the sloppy joint, etc.

These factors may be resolved for any particular pole assembly so that the looseness of the sloppy joint and the distance that the sloppy joint is located from the pole are such that the sloppy joint is effective to damp induced vibration for the particular arm and load carried by the arm that form a part of the pole assembly.

In addition to the foregoing factors, many other variables are involved. These include the manner in which vibration is induced, that is by wind or other source of energy; and when the vibration is wind-induced, the nature or types of wind-induced vibration is involved. Because of these variables and their interrelation, an exact scientific explanation of the theory concerning how the loose or sloppy joint controls induced vibration of pole structures of the character described to a nondestructive degree is difficult to formulate.

Nevertheless, the fact remains that induced vibration of a pole structure may be controlled so as to be nondestructive by introducing a loose or sloppy joint or coupling in the pole-arm assembly.

Accordingly, the present invention provides a new pole structure controlling, reducing, or eliminating vibration induced from any source of energy to a nondestructive degree; provides a new pole structure which breaks down, damps or interrupts the regularity of any vibration pattern induced by wind or other source of energy; and provides a new pole structure eliminating difficulties existing in the art and solving a longstanding problem.

In the foregoing description certain terms have been used for brevity, clearness and understanding; but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such terms are used for descriptive purposes herein and are intended to be broadly construed.

We claim:

1. Vibration damping construction for long pole arms mounted on poles including, a pole having upper and lower ends; an arm mounting member fixed to the pole adjacent the upper end of the pole and having a portion extending laterally of the pole; an elongated tubular arm member having inner and outer ends; a load member mounted on the outer end of the arm member; the inner

tubular end of said arm member being telescoped over the laterally extending portion of said mounting member; the maximum outer diameter of the mounting member being smaller than the minimum inner diameter of the telescoped portion of the tubular inner end of the arm member at any corresponding section of the telescoped portions of said members, thereby providing clearance between the telescoped portions of said members and forming a loose joint connection therebetween; means securing the telescoped members together in position to maintain the loose joint condition of the connection between the telescoped members; said arm mounting member and said securing means being the sole means supporting said arm member on said pole; and said securing means including, bolt means secured to one of the mounting and arm members, and a loose joint connection between said bolt means and the other of said mounting and arm members; whereby vibration induced in the load carrying pole arm from any source of energy is controlled to a nondestructive degree by said loose joint connections.

2. The construction defined in claim **1** in which the telescoped portions of the mounting and arm members are each tapered, and in which said clearance and loose joint connections are provided and maintained between said telescoped tapered portions.

References Cited

UNITED STATES PATENTS

2,172,137	9/1939	Ewing	287—54
2,873,904	2/1959	McCormick	256—65 X
3,211,482	10/1965	Sorenson	287—58
1,840,048	1/1932	Michelman.	
1,870,770	8/1932	DeWitt	285—332 X

FOREIGN PATENTS

502,679	5/1951	Belgium.
944,532	11/1948	France.
5,942	4/1915	Great Britain.

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