Oct. 6, 1959 R. W. HEINZEN 2,907,543

SUPPORT FOR A PENDANT TYPE LUMINAIRE

Filed Aug. 15, 1955 3 Sheets-Sheet 1

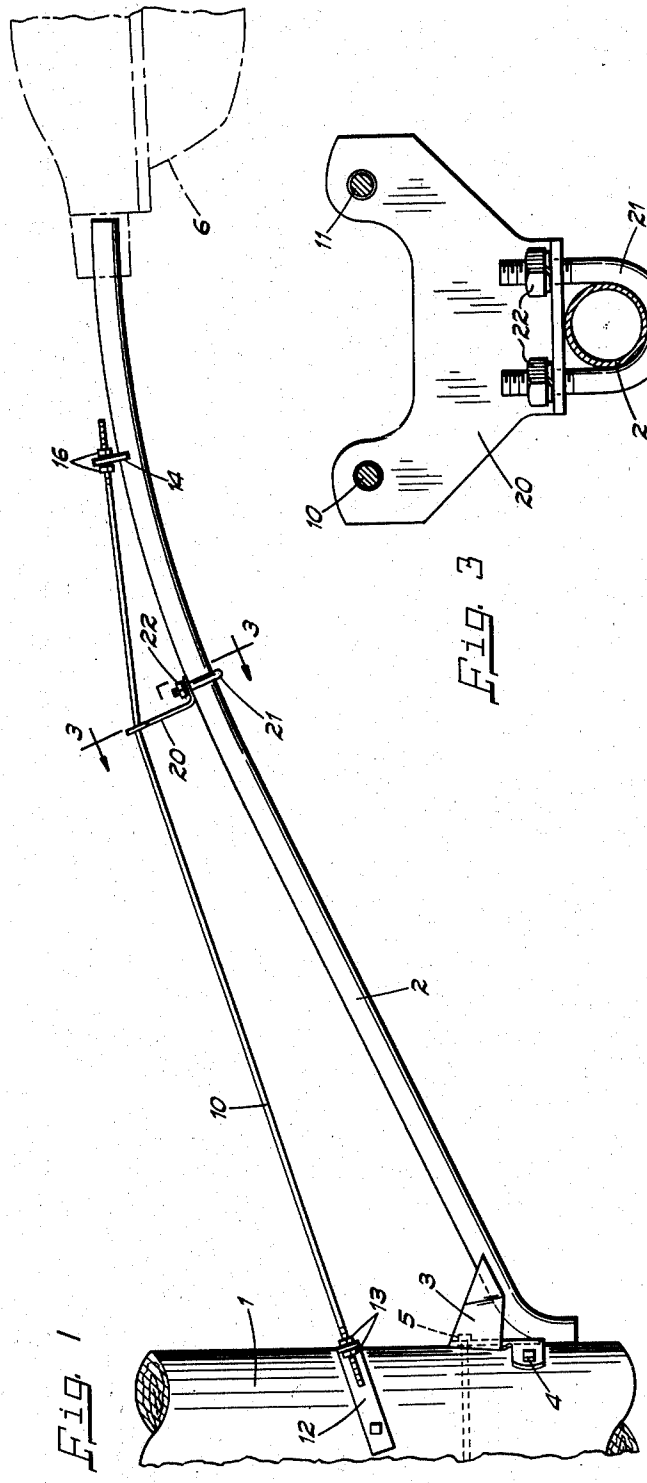

Fig. 1

Fig. 3

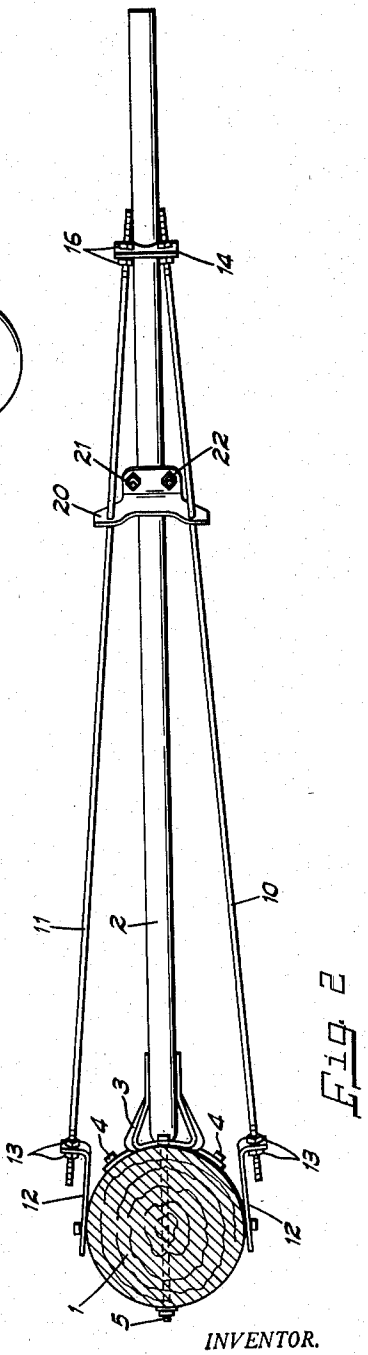

Fig. 2

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SUPPORT FOR A PENDANT TYPE LUMINAIRE

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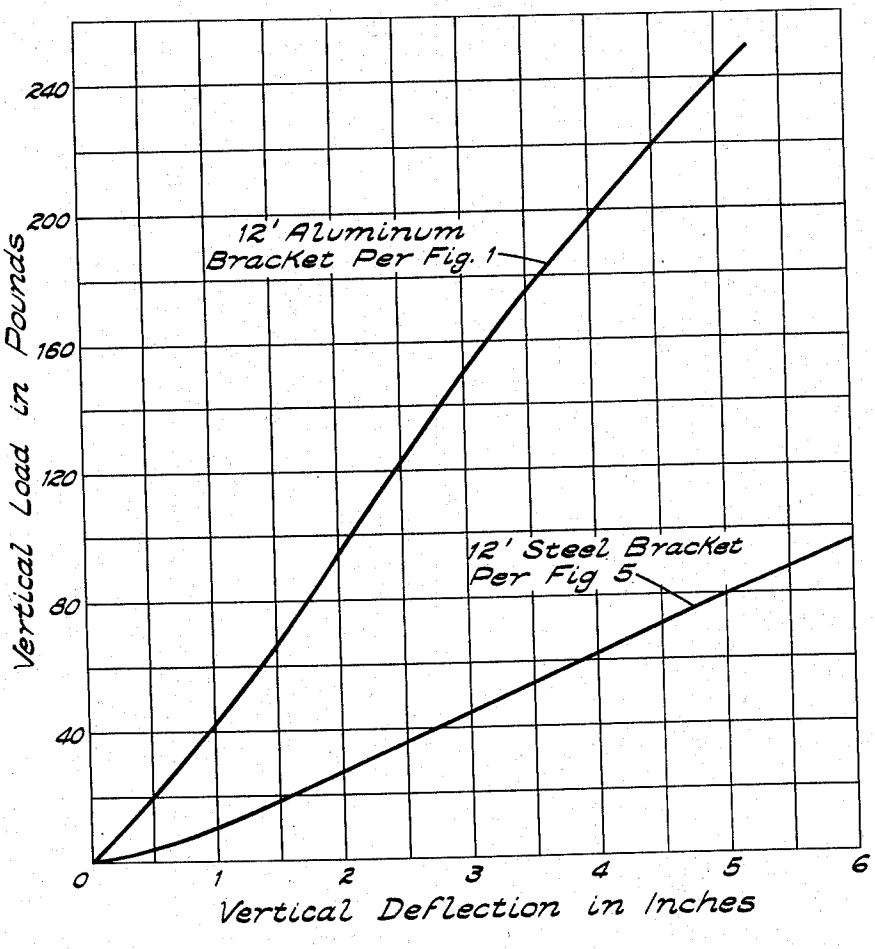

Fig. 4

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SUPPORT FOR A PENDANT TYPE LUMINAIRE

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Fig. 5

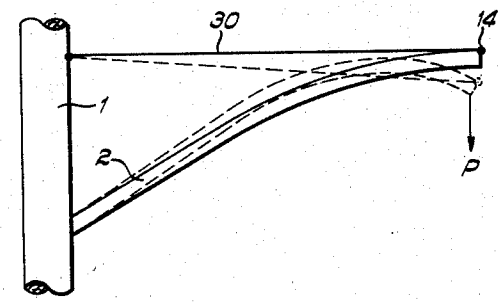


Fig. 6

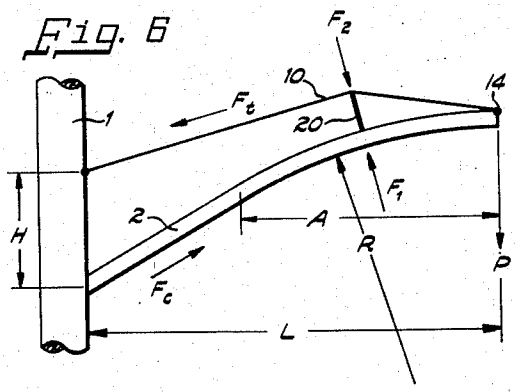


Fig. 7

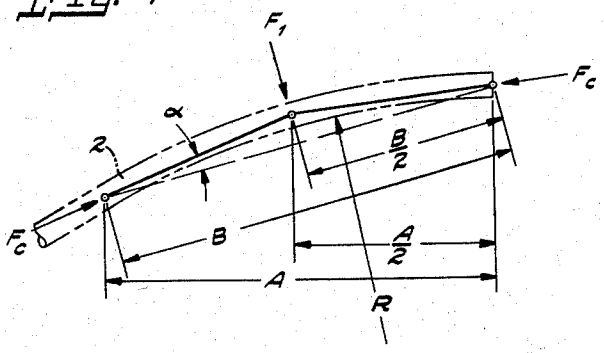


Fig. 8

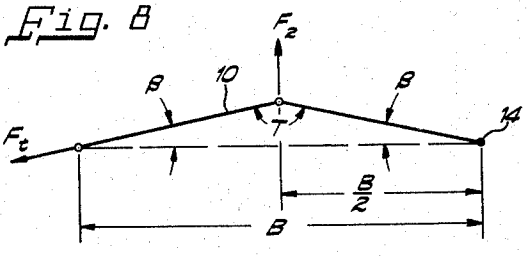


Fig. 9

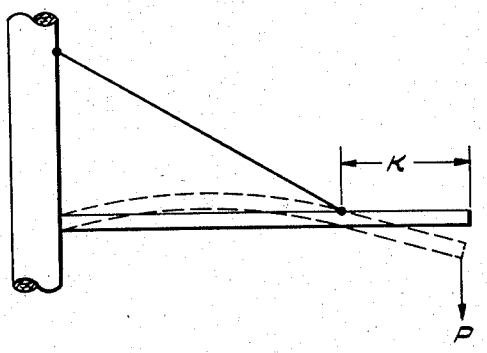
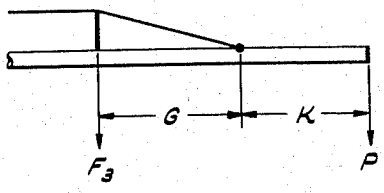


Fig. 10



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SUPPORT FOR A PENDANT TYPE LUMINAIRE

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Application August 15, 1955, Serial No. 528,394

3 Claims. (Cl. 248—221)

The present invention relates to supporting brackets, and particularly relates to brackets of the upsweep type adapted to support a pendant load, such as a street light or highway luminaire, from the terminal end thereof.

In the field of street lighting, there has been an increased tendency over recent years to provide support brackets of relatively extended length. This is especially true for installations adjacent roadways which extend past urban areas, requiring the supporting pole or standard to be spaced a considerable distance laterally of the road. For safety reasons the pole may not be mounted on the shoulder of the road, and very often it must be mounted even farther from the road because of a drainage ditch being provided adjacent the shoulder. In many instances, in order to mount a pole on firm ground laterally adjacent a road having both a shoulder and a drainage ditch, the support bracket extending laterally of the pole may be even as much as 20 ft. in length from the pole end to the terminal end.

Positioning of poles on boulevard dividing strips and where spreading trees may obscure projected illumination, also requires extended length mast arm portions of the bracket. Obviously, the extended length subjects the bracket and the pole to considerable stress and strain even under normal weather conditions.

Wind loading has become a decided factor in strength requirements of street lighting components. In the past, luminaires were small and their supports were short. But today, with increased demands for quality lighting requiring large luminaires have resulted in the need for greater appreciation of wind loading.

In order to provide properly designed supports, two very important factors must be considered. These are pole space used and strength requirements. Naturally, both of these factors must be weighed and results accomplished with an aesthetically pleasing support. Poles and other upright suport members are often used for multiple purposes. For instance, it is quite normal for a pole to be used for supporting primary lighting and other electrical circuits, in addition to carrying telephone lines with multi-circuit installations. It is also considered to be good practice to mount the street lighting luminaires at a considerable height from the street; for instance, as much as 30 ft. In the past, with luminaire brackets of 12 ft. in length extending laterally from a pole, it was necessary to utilize as much as 4 ft. of pole space to mount a supporting guy member above the bracket pole plate. It will be readily apparent that if the pole is to be used for multiple purposes, it is a decided advantage to provide a bracket requiring a minimum amount of pole height for adequate support.

Certain basic standards for bracket design have become accepted in the industry and include the following provisions:

(1) Less than 5% deflection in support lengths when a 100 pound vertical load is applied. This consideration allows for ice and luminaire loading.

(2) Less than 2 degrees terminal deflection through

the range 10 to 40 pounds vertical load. Thus, the light distribution pattern will not be offset.

(3) Less than 5% deflection in support lengths when a 50 pound lateral load is applied. This consideration allows for wind loading of both the support and the luminaire.

(4) Ultimate load of 250 pounds without failure. This assures support of a man in case he would lose his balance during maintenance operations and grasp the support.

In addition, of course, the supports should be attractive and easy to install.

The aesthetic considerations of a supporting bracket for a street lighting luminaire generally persuade a designer to provide a bracket of the upsweep type having a radius of curvature intermediate its ends. The main problem in curving a compression member, such as a loaded mast arm, is the tendency for that member to buckle under load in the direction of the curve. Another problem, introduced because of using a guy rod or rods in tension is that the tension rod is not attached at the very end of the compression member. This introduces a tendency for the compression member to rotate about the point where the rod is attached. The distance between the attachment point and the terminal point of the mast arm is necessary to permit proper mounting of a luminaire.

The present invention contemplates the use of a properly designed and located brace or strut inserted between the guy rod or rods and a curved compression member, such as a street light mast arm, to cause a load applied on the support to produce on the compression member a deflecting and straightening force to counteract the buckling and rotation problems. In addition, the use of a spacer strut or brace results in a design which acts to materially reduce the vertical space needed for mounting the bracket. Thus, more pole space is made available for other equipment. The use of a spacer strut of proper design and location also adds considerably to the rigidity of the extended mast arm to provide a minimum lateral deflection at the terminal end. This is especially true when double guy rods are used.

It is an object of the present invention to provide a support bracket for mounting pendant loads, such as highway lighting luminaires, laterally spaced from an upright member, which bracket utilizes a minimum number of cooperating members and requires a minimum amount of pole height for securing the said parts thereto.

It is another object of the present invention to provide a supporting bracket for highway lighting luminaires which is aesthetic in appearance and of a design of maximum ultimate strength, and having a minimum vertical and lateral deflection at its terminal end under loading conditions.

It is a further object of the present invention to provide a luminaire support bracket of the upsweep type which includes a tension guy member vertically spaced above the pole plate and attached intermediate the ends of the bracket, and further which includes a spacer strut or brace inserted between the said guy member and compression bracket member, said strut being of particular length and location relative to the supporting bracket assembly.

In the drawings:

Fig. 1 is a side elevation view of a supporting bracket constructed in accordance with the present invention, and shown mounted on a pole with a street light luminaire being mounted on the terminal end and illustrated in dot-dash lines.

Fig. 2 is a top plan view of the bracket of Fig. 1.

Fig. 3 is a sectional view taken on lines 3—3 of Fig. 1.

Fig. 4 is a graphical representation of compositive

curves plotted from vertical loading data versus vertical deflection of supporting brackets of the prior art and of brackets embodying the present invention.

Figs. 5–10 are diagrammatic views of brackets and various representative portions thereof illustrating certain aspects to be considered in the proper dimension and location of the spacer strut or brace embodied in the present invention.

A preferred embodiment of the supporting bracket is illustrated in Figs. 1, 2 and 3, wherein the bracket assembly is shown mounted on an upright wood pole or standard 1. The assembly comprises an upsweep mast arm 2 attached to the pole 1 by means of a pole plate 3. The pole plate is here shown welded directly to the pole end of the mast arm, but may be of many of several conventional designs. The pole plate 3 is preferably mounted on the pole by means of lag screws 4 and thru bolt 5. The mast arm is preferably of conventional tubular type of industry-accepted dimension for receiving the slipfitter portion of a luminaire 6 at the terminal end thereof. The luminaire is shown here in dotted lines, and may be of any of a vast multitude of varieties provided by several manufacturers.

Because of extended length of the mast arm 2, which may be as much as 20 ft. in certain cases, tension members in the form of guy rods 10 and 11 are provided for added support. The guy rods are fastened at the pole end by means of L-shaped brackets 12 and are threaded for adjustment by means of adjustment nuts 13 engaging the rods and respective brackets. The guy rods 10 and 11 are fastened at their terminal end to the mast arm 2 by means of adjustable engagement with a guy rod support 14 having apertures therein for receiving the threaded terminal end of the guy rods and appropriate adjustment nuts 16. The guy rod support 14 may be welded to the mast arm 2, as shown, or mounted in any of several ways (not shown), as by means of a U-bolt or the like.

The present invention contemplates the use of a guy rod brace or strut intermediate the ends thereof, and being of particular proportion and location relative to the mast arm 2 and guy rods 10 and 11. Although double guy rods 10 and 11 are disclosed herein, it will be apparent as the description proceeds that a single guy rod (not shown) may be used for relatively shorter length mast arms without departing from the scope of this invention. In addition, it is often conventional practice, especially in the case of relatively extended length mast arms, to utilize what is conventionally known as an A-frame construction of the mast arm portion (not shown). This latter construction permits the mast arm pipe to be extended laterally of the pole and supported from the pole by means of angularly relative angle irons welded thereto. It is to be understood that the double guy rod construction is shown here for illustrative purposes only, and that the teachings of the present disclosure will serve equally well for any upsweep mast arm assembly in compression when loaded and including one or more tension members, such as guy rods, for additional support.

In the present embodiment, the guy rod strut or brace 20 is formed from a stamping into a general L-shape as shown in Figs. 2 and 3 and includes apertures for slidably receiving the guy rod at the upper end thereof, and also in its lower end to receive a conventional U-bolt 21 being fastened in place by means of nuts 22 threaded thereon.

As has previously been stated, the upsweep mast arm has a radius of curvature intermediate its ends mainly for aesthetic purposes, which configuration introduces two major strength problems. Inasmuch as the mast arm 2 is curved, there is introduced a tendency to buckle when placed in compression by applying a load, such as the luminaire 6, at its terminal end. This is even a greater problem than if a straight mast arm were to be provided, as the curvature has already started the arm in a direction towards buckling. However, when a straight arm is placed in compression, it may buckle in either direction if a great enough force is applied at its outer end.

The second problem arises because of the requirement of the point of attachment of the tension member, or members, and the mast arm must be spaced inwardly from the terminal extremity in order to accommodate conventional luminaires. When it is considered that many luminaires weigh as much as forty pounds, and that the guy rod support 14 is positioned in many cases as much as 18 inches inwardly of the terminal end, there is a considerable rotative moment introduced, with the point of attachment acting as a pivot.

The present invention contemplates the counteraction of the above introduced forces by the provision of a properly proportioned and located guy rod strut or brace.

The selection, dimension and location of the strut or brace 20 is determined by means of the following procedure:

Referring to the diagram of Fig. 5, there is illustrated a conventional supporting bracket assembly utilizing a member under compression, such as the tubular mast arm 2 and a tension member or members, such as the guy rod 30. Both members are fastened to the pole in accordance with recognized practice, and for the sake of convenience in description, it is assumed that the terminal ends of both members are attached at their extremity. Thus, for the moment, any tendency of the mast arm to rotate about the point of attachment when a load P is applied, will not be considered.

As stated previously, in a luminaire support of the construction shown in Fig. 5, having an upsweep curved compression member, there will be a tendency to buckle at the curved portion. This compression member, or mast arm 2, can be compared to a column under compression that has already been deflected beyond its critical point. Any compressive load will cause it to deflect and ultimately buckle in the direction of the curve. Obviously, this tendency towards buckling will be increased as the total length of the compression member is extended.

The present invention contemplates the use of a spacer member, or guy rod brace 20 positioned between the guy rod or rods and the mast arm as shown in Figs. 1, 2, 3 and 6. It is understood that struts have been placed between these members heretofore, but they have only been prescribed for increasing the rigidity of the entire assembly without consideration for proper location and dimension to compensate for the tendency of a curved compression member to buckle, and to correct for rotative moment about the point of attachment, as will hereinafter be described. The tendency to buckle under load P is illustrated in Fig. 5 in the dotted line portion.

An examination of the diagram of Fig. 6 will illustrate the force diagram for the assembly under load with the strut 20 being inserted between the tension member 10 and the compression member 2. The diagram of Fig. 6 is representative of the forces imposed upon the various members of the structure of Figs. 1–3. The buckling tendency may be cancelled by inserting the strut 20 between the guy and the mast arm, wherein the strut is of such length and location that the upward buckling force F_1 of the arm will be balanced by a downward force F_2, which is caused by the tendency of the guy rod to straighten under load. The maximum buckling tendency will occur at the mid point of the curved section between the guy attachment point and the point where curvature ceases. This has been found to be the preferred location for the spacer strut 20. The load P will cause the curved arm to be compressed by a force designated by the arrow F_c, whereas the tension member force on the guy rod is designated by the symbol F_t.

The length L, the dimension H, A and the radius of curvature R of the arm, are determined by other considerations including aesthetics and available pole height.

At any load P, the compressive force F_c and the tension force F_t can be determined by conventional procedure. The forces will be substantially equal and opposed to one another. As far as the dimension H is concerned, there is this to consider; in the case of a double guy rod construction as shown in Figs. 1–3, it has been found that when H is held to a minimum, the lateral deflection will approach a minimum value for the guy construction used. However, the H dimension is also necessary for offering added vertical strength components. It then becomes necessary to balance both factors. By introducing a properly constructed and located strut or brace **20**, the H dimension can be held to a minimum for providing adequate pole space above the point of attachment without detrimentally affecting vertical strength.

The buckling force F_1 may be determined, as illustrated in Fig. 7, by treating the curved portion A of the mast arm **2** as a triangle, with the force F_c being applied along the sides thereof. The angle α may be determined from a layout similar to that of Fig. 7, or as follows: From an examination of the diagram of Fig. 7, it will be readily apparent that the angle α is approximately equal to ¼ arc tan B/R. It will then be seen that the force F_1 is equal to the compressive force F_c multiplied by the sine of the angle α.

Referring now to the diagram of Fig. 8, it will be seen that the guy rod, or tension member **10** may be angularly proportioned to develop the compensating force F_2 as follows: Let F_2 be equal to F_1. It will then be seen that the angle β defined by the necessary height of the strut **20** may be determined from the equation: Sine $\beta=F_2/F_t$. The angle T will then be equal to $180°-2\beta$. After the angle T is determined, the length of the spacer strut necessary to maintain that angle may be found immediately by layout.

Although no particular attention has heretofore been considered in the present description relating to the strength of material consideration, it must be assumed that the guy rod or rods, mast arm and spacer materials are chosen of sufficient strength to receive the necessary loads applied to them, in addition to accounting for a considerable factor of safety.

As stated heretofore, the above procedure was outlined with the assumption that the guy rod was to be attached at its outer extremity directly to a point on the mast arm vertically of the load P. However, in actual practice, there is a considerable free length of mast arm extending beyond this point for proper attachment of a luminaire. This may often be as much as 18 inches in a mast arm of the length of 12 ft. measured laterally from the pole. Referring to Fig. 9, it will be apparent that such attachment will result in a couple, tending to rotate the arm about the guy rod attachment point. This free end dimension K provides a considerable factor which must be considered in the calculations to permit a proper design of spacer strut to compensate for both the tendency of the pipe to buckle and for the rotative moment introduced.

For purposes of calculation, the portion K of the arm between the spacer strut **20** and the point of load attachment may be treated as a lever with its fulcrum at the guy attachment point, as shown in Fig. 10. The force F_3 required to neutralize the moment at that point is:

$$F_3=\frac{PK}{G}$$

The angle T on the guy rod must then be modified to permit F_2 to equal F_1 plus F_3. It will be obvious that in normal practice, the calculations will consider the rotative force F_3 immediately on determination of the angle T. The present procedure has been outlined as above for the sake of clarity in discussion.

Another factor that must be considered in determining whether double guy rods should be used rather than a single guy rod, is that there is some instability introduced by heavy loads due to the tendency of the strut **20** to rotate, which must be opposed by the torsional strength of the mast arm. If double guy rods are used with considerable spacing between each other of the spacer strut and pole, then they will counteract any mast arm torsion under vertical loading, and tend to reinforce the lateral strength by introducing a torsional component to the pipe.

It is interesting to note the relative strength and pole height considerations provided by the introduction of the properly designed and located spacer strut. Attention is now directed to the curves of Fig. 4, wherein the calculations for the curves were determined from tests on substantially comparable designs of a supporting bracket, such as the preferred embodiment shown in Figs. 1, 2 and 3, and of a conventional bracket, diagrammatically illustrated in Fig. 9. In addition, it is even of more worthy note to observe that the curve of the structure of the preferred embodiment was laid out from tests on an all aluminum mast arm, as compared to a steel mast arm according to a diagram of Fig. 9.

In making the tests, both structures were of a total mast arm length of 12 ft. The pole height H in the steel structure was 4 ft. as opposed to a height of 18 inches in the aluminum structure. This is a considerable saving in pole height and permits the luminaires to be mounted at optimum height above street level for proper illumination and also provides additional space for poles designed for multiple use. A very graphic difference will become immediately apparent from Fig. 4, when it is observed that a pendant load of only 80 pounds deflected the steel structure 5 inches when no brace or strut was used, whereas the 5 inch deflection in the aluminum structure was obtained only after applying a load of 240 pounds.

A close observation of the structure of Figs. 1 and 2 will reveal that, in the present case, the brace **20** is positioned slightly inwardly of the center of the curved portion of the mast arm **2**. In commercial practice, luminaires are generally provided with mast arm slipfitters of only two different diameters. It will be obvious that the procedure outlined above relates to optimum practice for a particular length mast arm, and that relatively shorter mast arms of the same diameter will permit shifting inwardly of the strut **20** for ease in manufacture and assembly without departing from desired strength characteristics of the novel bracket assembly.

It will be apparent that an improved supporting bracket has been provided for supporting pendant loads laterally spaced from a vertical support, which bracket includes a guy rod spacer of proper dimension and location relative to the various support members to provide a minimum amount of pole space for mounting and which further provides a maximum degree of rigidity in both vertical and lateral deflection characteristics.

I claim:

1. A support for a pendant type luminaire in laterally spaced relation to an upright member comprising in combination, a mast arm normally under compression and subject to unbalanced buckling forces attached at one end to said upright member by means of a pole plate and having a free outer end for supporting a luminaire, an elongated tensioned guy member having first and second portions in angularly disposed relationship to each other and having a point of confluence intermediate the ends of said guy member, said guy member being attached at one of its ends to said upright member and at the other of its ends to said mast arm, strut means attached to said mast arm intermediate the ends thereof and engaging said guy member at said point of confluence of said first and second angularly disposed portions, said point of confluence being in vertically upwardly spaced relation to the point of attachment of said one end of said guy member to said upright member whereby said strut means is placed under compression for counteracting said forces tending to buckle said mast arm.

2. A support for a pendant type luminaire in laterally spaced relation to an upright member comprising in combination, an elongated curvilinear mast arm normally under compression and subject to unbalanced buckling forces, said mast arm being attached to a lower end to said upright member by means of a pole plate and rising generally upwardly to a free outer end for supporting a luminaire, an elongated tensioned guy member having first and second portions in angularly disposed relationship to each other and having a point of confluence intermediate the ends of said guy member, said guy member being attached at one end to said upright member in vertically spaced relationship to said pole plate and at the other end to said mast arm in proximity to said free outer end, strut means attached to said mast arm intermediate the ends thereof and engaging said guy member at said point of confluence of said first and second angularly disposed portions, said point of confluence being in vertically spaced relation to the point of attachment of said one end of said guy member to said upright member whereby said strut means is placed under compression for counteracting said forces tending to buckle said curvilinear mast arm.

3. A support for a pendant type luminaire in laterally spaced relation to an upright member comprising

in combination, a mast arm normally under compression and subject to unbalanced buckling forces attached at one end to said upright member by means of a pole plate and having a free outer end for supporting a luminaire, a pair of elongated tensioned guy members each having first and second portions in angularly disposed relationship to each other and each having a point of confluence intermediate the ends of said guy members, each of said guy members being attached at one of its ends to said upright member and at the other of its ends to said mast arm, a strut member attached to said mast arm intermediate the ends thereof and engaging each of said guy members at each of said points of confluence of said first and second angularly disposed portions, said points of confluence being in vertically spaced relation to the point of attachment of each of said one ends of said guy members to said upright member whereby said strut member is placed under compression for counteracting said forces tending to buckle said mast arm.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,907,543 October 6, 1959

Ruth W. Heinzen

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, line 5, for "attached to" read -- attached at --.

Signed and sealed this 5th day of April 1960.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON

Commissioner of Patents