TAPERED TUBULAR POLE

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The invention relates to tapered poles made from rolled metal, preferably steel sheet or plate metal, and the poles being suitable for use where transverse loading prevails and subjects the poles to bending and/or to torsion, such as in telephone, telegraph, transmission, and trolley; wire suspension poles, and this application is a continuation in part of my copending application for apparatus and method of making tapered tubular poles, filed July 26, 1927, Serial No. 208,491, matured in Patent No. 1,746,281, dated February 11, 1930.

The bending formula for computing the safe transverse load in lbs. which may be applied to a tapered tubular pole is as follows:

\[ P = \frac{1600(L - d^2)}{D} - \frac{1333(D - d^2)}{12D^2} \times \frac{1333(L - d^2)}{D} \times \frac{1333(L - d^2)}{D} \times \frac{12D}{D^2} \]  

where,

- \( P \) = Safe transverse load in lbs.,
- \( L \) = Distance of point of application of load from any section in feet,
- \( S \) = The allowed fibre stress in lbs. per square inch,
- \( I \) = The moment of inertia of the section,
- \( C \) = Distance to the outer fibre from the neutral axis in inches,
- \( A \) = The area of the section having “D” diameter in square inches,
- \( D \) = The outside diameter of the section in inches,
- \( a \) = The area of section having “d” diameter in square inches,
- \( d \) = The inside diameter of the section in inches.

Hence, it is desirable to taper the pole so that the diameter thereof increases, as the distance from the base of the pole to the point of application of the load increases, because, from the formula where \( P \), the load has a constant known value, as \( L \) increases, \( \frac{D'}{d'} \) should increase in direct proportion with.

The bending formula noted above, however, applies only to tension stresses and does not apply to compression stresses which cause buckling of a tubular pole, and for that reason, it is impossible to predict therefrom the actual performance of any tapered pole under transverse load conditions, which cause the same to act as a column on the compression side. It is for this reason that the actual performance of a tapered tubular pole can only be determined by actually constructing and testing a full sized pole.

Even in cylindrical poles of practical lengths, acting as columns, the unit stress existing cannot be calculated, and the design depends upon the use of empirical formulas which have in them certain constants determined from actual tests of columns, and such empirical data was not available with respect to tapered tubular metal poles prior to the present improvement.

Nature has provided trees with tapered trunks, and accordingly wooden poles have been used for years for such purposes; and metal poles of types other than disclosed herein have also been used, but many difficulties and disadvantages are encountered when such wooden and metal poles have been utilized.

Wooden poles are subject to relatively rapid deterioration by rotting and destruction by parasites, and it is common knowledge that they lack uniformity in structure and strength. Moreover, although they have a desired flexibility in normal weather conditions, they stiffen in moist freezing weather and lose their resilience and become brittle and break under transverse loading.

Steel tubular poles have been made from a plurality of sections of cylindrical pipe having increasing diameters, joined together by unions or by overlapping, thus providing a great excess of metal at the joints between the sections. The increase in strength in such metal poles is not uniform, not only because of the excess of metal at the section joints, but also because each section is of constant diameter; consequently there is a great deal of metal in such poles which performs no
useful function and which is accordingly wasted for all practical purposes.

Steel tubular poles have also been made by overlapping the ends of short sections of tapered tubes and welding the same together. The operation of welding is very costly and the resulting welds are never uniform; consequently their strength cannot be accurately determined. Accordingly when such poles have been made they have had a great excess of metal in their walls because the undetermined strength of the welded joints had to be properly taken care of by a high factor of safety.

In the past, sheet metal columns formed from a single sheet of metal have only been formed from light gauge metal as distinguished from heavy gauge metal, and if a column of any great height was desired, it had to be formed with an extremely large diameter in order to resist the transverse loads to which the column might be subjected. However, poles having such large diameters have never been formed or used because they have been unsightly and impractical for use because of their large diameters.

Prior efforts have failed in attaining an efficient use of sheet or plate metal for making a tapered tubular pole; and have also failed to produce a plain or fluted tapered tubular pole made of rolled sheet or plate metal, the sheet or plate metal being of heavy gauge, that is to say 11 gauge or thicker.

Moreover, all prior efforts have failed to produce a rolled sheet or plate metal longitudinally seamed tapered pole for carrying telephone, telegraph, transmission, or trolley wires, or for supporting lighting devices, having a substantially circular cross-section, or for other similar load carrying purposes, and having a length of 20 feet and upwards.

Finally all prior efforts have failed to produce such a tapered, tubular pole of rolled sheet or plate metal, and having a base of relatively small diameter.

It is therefore an object of the present improvement to provide a tapered tubular pole capable for use for carrying telephone, telegraph, transmission or trolley wires, having a height and diameter substantially the same as wooden poles which are at present in common use. Further objects of the present invention are to make the pole of one piece of rolled metal; to provide a rolled metal tapered tubular pole having a maximum strength to resist the bending moment caused by the transverse loading and a minimum weight of metal, or in other words to provide such a rolled metal tapered tubular pole having a much greater strength than any other type of pole of the same weight heretofore made, or to provide such a pole having a strength equal to that of any other type of pole heretofore made, but having a much lower weight.

The foregoing and other objects are attained by the present invention, which may be set forth in general terms as constituting a tapered tubular pole having a height of twenty or more times its base diameter, and preferably of twenty feet or over, the pole being formed preferably of a single piece of longitudinally continuous rolled metal, preferably steel sheet or plate metal having a uniform thickness of 11 gauge or thicker.

Such a pole may be produced by utilizing the apparatus for and method of making tapered tubular poles disclosed in my co-pending application, Serial No. 208,491, filed July 26, 1927, matured in Patent No. 1,746,981, dated February 11, 1930, of which this application is a continuation in part.

If it is desired, the pole produced by the apparatus shown in my application, Serial No. 208,491, may be further strengthened by fluting the same according to the method disclosed in the copending application of Carl A. Frahm and myself, Serial No. 249,358, filed January 25, 1928, matured in Patent No. 1,777,980, dated September 30, 1930.

An embodiment of the invention is illustrated in the accompanying drawings, in which

Figure 1 is a plan view of a tapered sheet metal blank from which a pole is formed;

Fig. 2, a plan view of the blank after it has been partially formed;

Fig. 3, an elevation of a completed tapered tubular pole made from the sheet blank shown in Fig. 1, the longitudinal edges of the partly formed blank shown in Fig. 2 having been welded together to form a longitudinal seam;

Fig. 4, an elevation of a tapered tubular fluted pole which may be produced by fluting the pole shown in Fig. 3;

Fig. 5, a section as on the line 5–5, Fig. 1;

Fig. 6, a section as on the line 6–6, Fig. 2;

Fig. 7, a section as on the line 7–7, Fig. 3; and

Fig. 8, a section as on the line 8–8, Fig. 4.

Similar numerals refer to similar parts throughout the several figures shown in the drawings.

In making the pole, a sheet blank having a uniform thickness throughout is sheared to have a trapezoidal outline as shown at 10 in Fig. 1. The sheet blank 10 may then be passed through curved rolls and through a
tapered tubular funnel having a tapered core therein for being cylindrically formed as far as the metal of the blank reaches as shown in Figs. 2 and 6. The apparatus shown in my copending application, Serial No. 398,401, filed July 28, 1927, matured in Patent No. 1,746,281, dated February 11, 1930, may be used to carry out these operations.

The partially formed blank 11 may then be passed through a tapered tubular expansible die having a plurality of sections for forming the blank to be tubularly tapered, for bringing the edges 11a and 11b in aligned abutment, and for welding together the edges 11a and 11b to form the longitudinal seam indicated at 12. The pole 13 thus produced having a plain round cross section without annular seams is shown in Fig. 3. Apparatus which may be used for carrying out these operations is likewise shown in Patent No. 1,746,281.

If it is desired to further add to the strength of the tapered tubular sheet metal pole, the same may be worked, rolled or fluted to produce the fluted pole shown at 14 in Figs. 4 and 8. This working, rolling or fluting may be carried out in accordance with the disclosure in the patent application Serial No. 249,339, filed by Carl A. Frahm and myself on January 25, 1928, matured in Patent No. 1,777,080, dated September 30, 1930.

The finished tapered, tubular welded pole as illustrated at 13 in Fig. 3 may thus have a length of 20 or more times the base diameter, the pole produced having a sufficient inherent strength to resist the transverse strains to which telegraph, telephone, transmission and trolley wire suspension poles are subjected.

It has been discovered by experimental tests that the most desirable taper for the pole formed of a single sheet of metal is approximately 0.225 inches per ft. of length total taper.

It has likewise been discovered from long series of experiments, considering not only the cost of material, but also the cost of production, that the most desirable thickness of sheet metal to be used is a heavy gauge sheet metal, that is to say sheet metal made on a plate mill which according to common practice is 11 gauge or heavier, and 11 gauge metal is substantially ⅛ of an inch thick.

Three specific examples of poles formed from a single sheet of metal and constituting embodiments of the present invention are as follows:

1. A plain pole having a length of 20 ft., having a base diameter of 1 ft., having a taper of 0.225 inch per ft. of length, and formed of 11 gauge metal (⅛ in.) has been discovered by actual test to withstand an ultimate transverse load of over 4,000 lbs., applied at the top of the pole. This pole accordingly has a length of 20 times its base diameter, a top diameter of 7½ inches, and a length of 82 times its top diameter.

2. A plain pole having a base diameter of 1 ft., a length of 36 ft., formed of 11 gauge metal, and having the above taper has been discovered by actual test to withstand an ultimate transverse load applied at its top of over 3,000 lbs. The length of this pole then is 26 times its base diameter, its top diameter is substantially 6 inches, and its length is substantially 82 times its top diameter.

3. A plain pole having a base diameter of 1¼ ft. and a length of 40 ft. formed of 11 gauge metal and having the above taper has been discovered by actual test to withstand an ultimate transverse load applied at the top thereof of over 3,000 lbs. This pole has a top diameter of 6 inches, and accordingly its length is 32 times its base diameter and 80 times its top diameter.

Such poles as have been specifically noted above have a weight of less than 75% of the weight of any other tubular metal pole heretofore known to have been made having substantially the same external dimensions and having an equal strength for resisting transverse loading, and likewise such poles have twice the transverse load resisting strength of any tubular metal pole heretofore known to have been made having the same weight. Such poles have a weight substantially equal to the usual wooden pole having the same profile or outside dimensions, but have a strength in excess of that of the usual wooden pole.

Pole No. 1, described above, has a length of 1,920 times the thickness of metal, and poles No. 2 and No. 3 have a length of more than 1,920 times the thickness. Where greater strength is desired, the thickness of metal may be increased preferably to 7 or 8 gauge metal or thicker. In such cases the ratio of thickness of metal to length of pole is correspondingly decreased.

The tapered tubular pole made of heavy gauge rolled metal with a considerable length and a relatively small diameter as described herein, has the following unusual characteristics:

1. It is lighter in weight than any other tubular metal pole of equal strength;
2. It is stronger than any other tubular metal pole of equal weight; and
3. It is stronger than a wooden pole of equal dimensions.

Moreover, it has been discovered by actual tests that the pole of the present invention not only has the necessary strength to resist the bending and buckling stresses arising from the normal conditions of loading, but is also substantially uniformly resilient throughout its length in all directions and under all conditions, so that the pole will flex without breaking or buckling under the un-
usual loads imposed by storms, shocks, and the like.
I claim:—
1. A one piece tapered, tubular sheet metal pole, having a length of 20 feet and upwards, made of 11 gauge or thicker metal, and having a length of 20 or more times its base diameter.
2. A one piece tapered, fluted, tubular sheet metal pole, having a length of 20 feet and upwards, made of 11 gauge or thicker metal, and having a length of 20 or more times its base diameter.
3. A tapered, tubular, sheet metal pole, having a length of 20 feet and upwards, made of a tapered sheet metal blank of 11 gauge or thicker metal, and having a length of 20 or more times its base diameter.
4. A tapered, tubular, worked metal pole, having a length of 20 feet and upwards, made of a tapered sheet metal blank of 11 gauge or thicker metal, and having a length of 20 or more times its base diameter.
5. A tapered, tubular, longitudinally seamed, sheet metal pole having a length of 20 feet and upwards, and having a plain round cross section made of 11 gauge or thicker sheet metal without annular seams.
6. A tapered, tubular, longitudinally seamed, sheet metal pole having a length of 20 feet and upwards, made of 11 gauge or thicker metal without annular seams.
7. A tapered, fluted, tubular, sheet metal pole, having a length of 20 feet and upwards, made of 11 gauge or thicker metal, and having a length of 20 or more times its base diameter.
8. A tapered, fluted, tubular pole made of rolled metal, and having a length of 20 feet and upwards and more than 20 times its base diameter, and a wall thickness of 11 gauge or thicker metal.
9. A tapered, fluted, tubular pole made of rolled metal, and having a length of 20 feet and upwards and a wall thickness of 11 gauge or thicker metal.
10. A tapered tubular pole comprising a formed wall of plate metal having a uniform thickness of 11 gauge or thicker, and having a length of 20 feet or greater.
11. A tapered tubular pole comprising a formed wall of plate metal having a uniform thickness of 11 gauge or thicker, and having a length of 20 feet or greater, and the length of the pole being equal to or greater than 20 times the diameter of its base.
12. A pole having a tapered tubular longitudinally continuous wall, having a length of 20 feet and upwards, and the wall consisting of rolled plate metal having a uniform thickness of 11 gauge or thicker.
In testimony that I claim the above, I have hereunto subscribed my name.
EDMUND W. RIEMENSCHNEIDER.