Aug. 12, 1952 T. N. COFER ET AL 2,606,952

TRANSMISSION LINE SUPPORT

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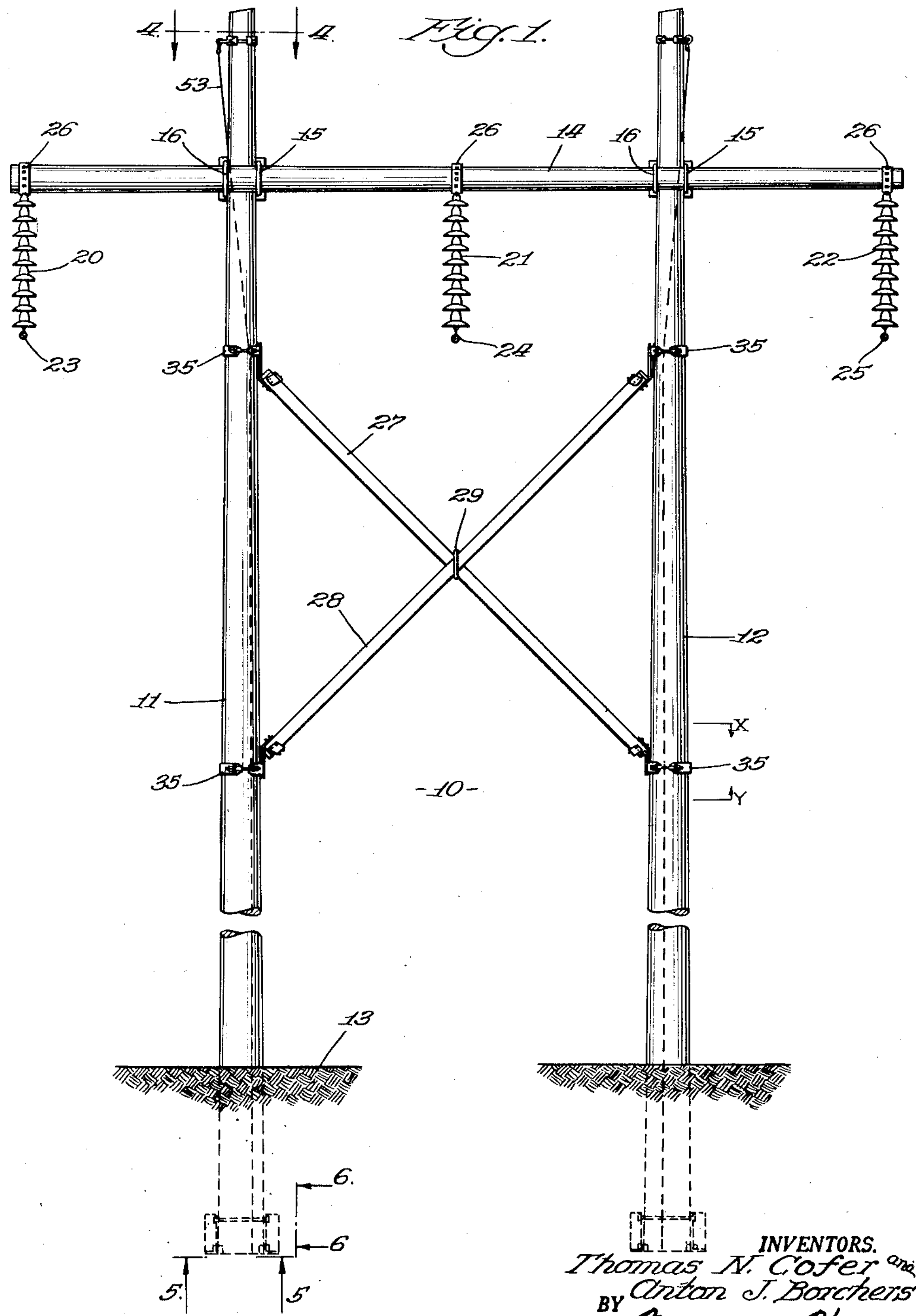
Fig. 1.



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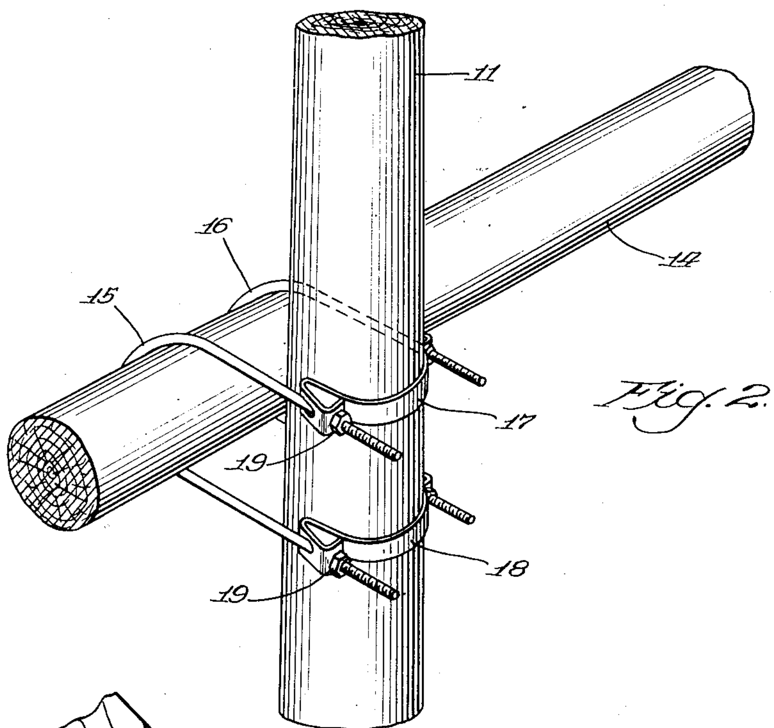

Fig. 2.

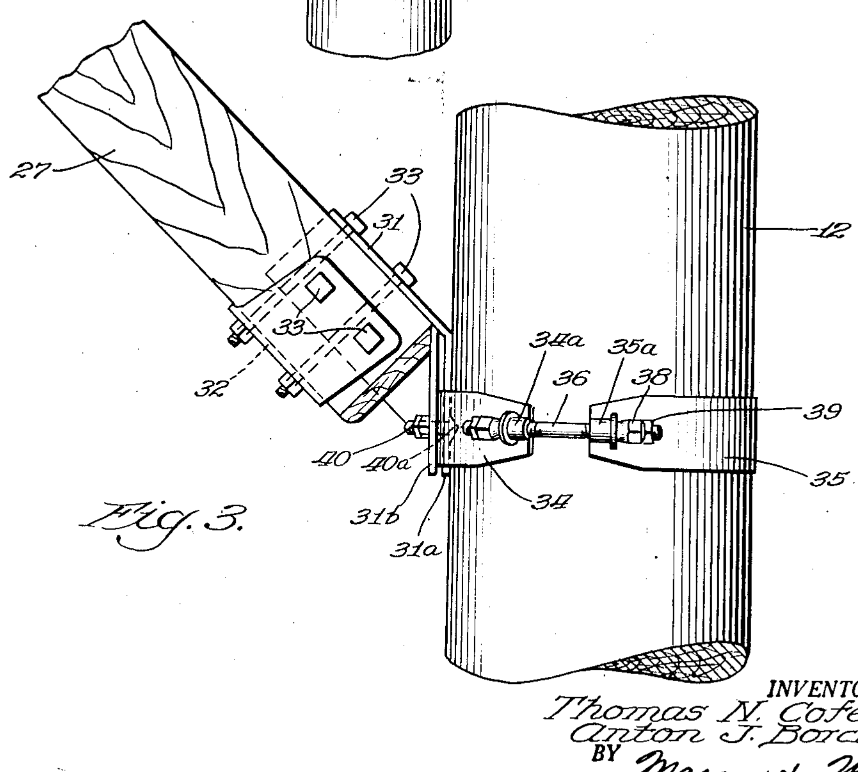

Fig. 3.

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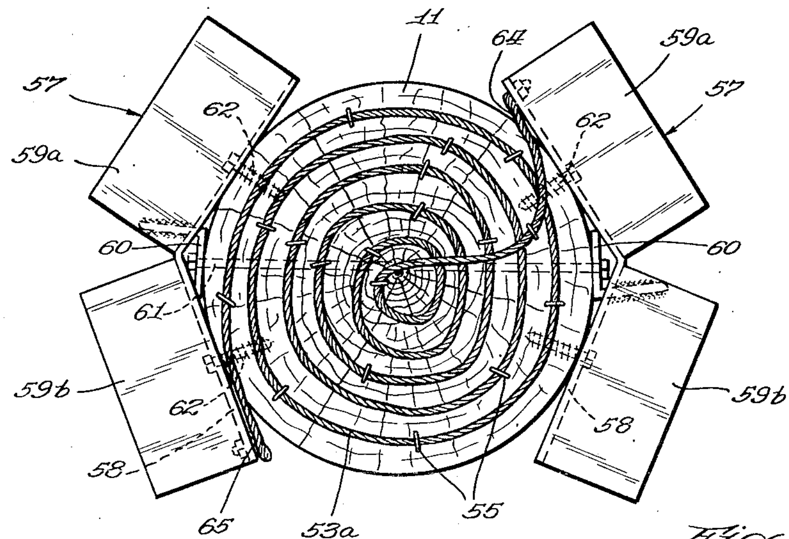

Fig. 5.

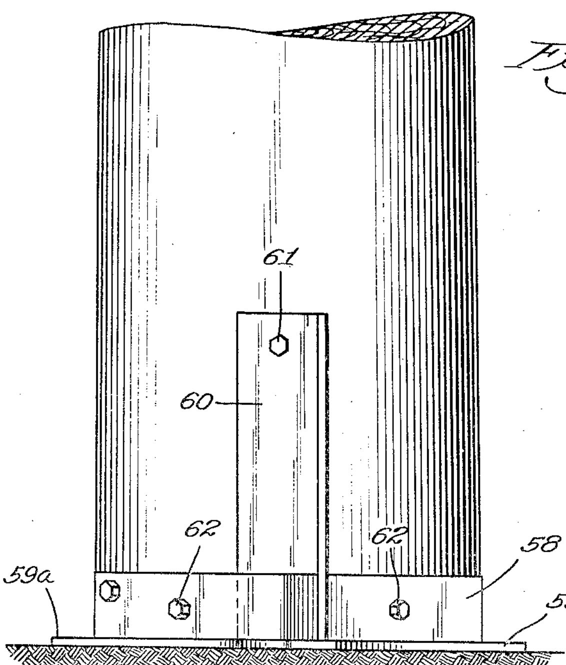

Fig. 6.

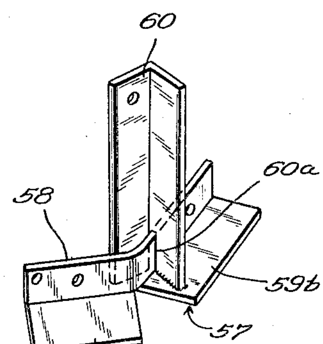

Fig. 7.

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TRANSMISSION LINE SUPPORT

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Fig. 4.

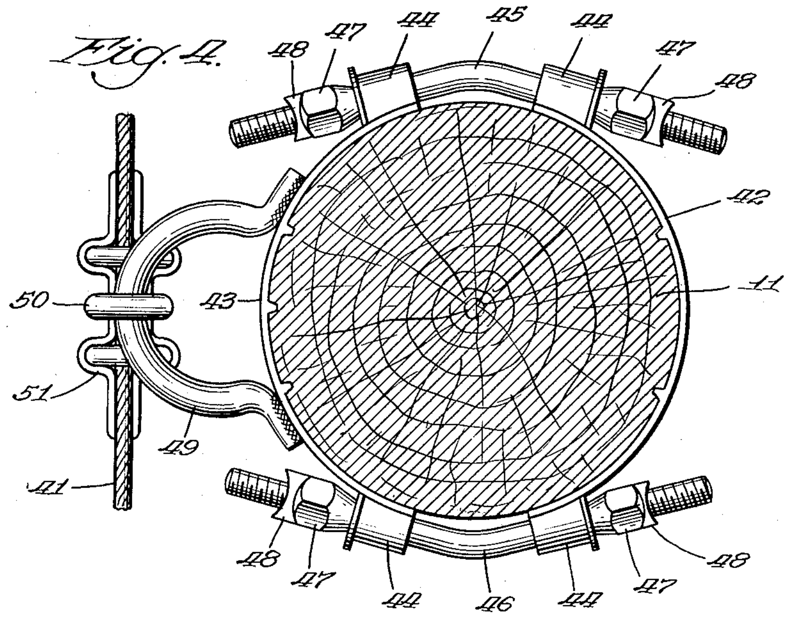


Fig. 8.

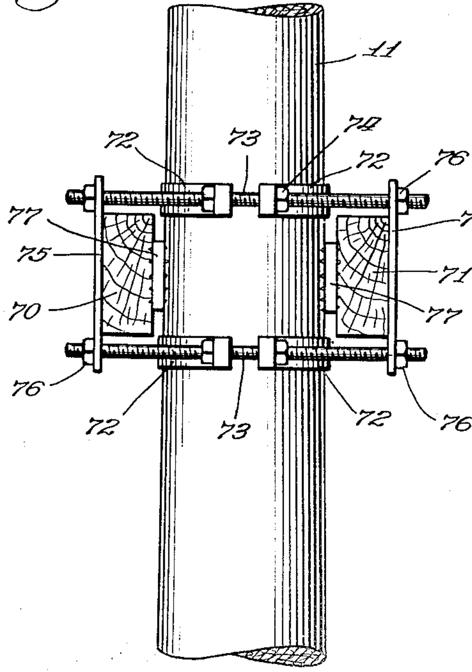
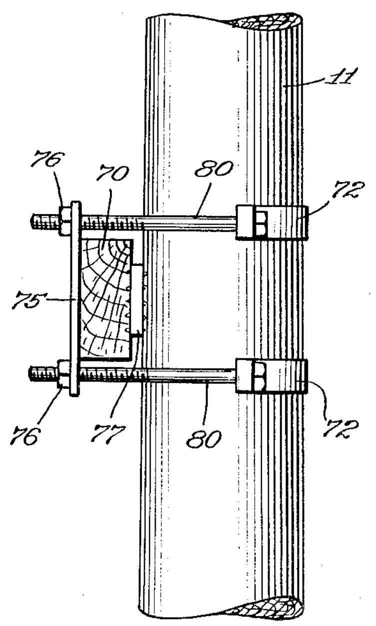


Fig. 9.



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UNITED STATES PATENT OFFICE

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TRANSMISSION LINE SUPPORT

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1 Claim. (Cl. 174—43)

The present invention relates to transmission line supports and more particularly to wood structures for supporting high voltage transmission lines.

In recent years wood structures have been extensively used in lieu of steel towers for supporting high voltage transmission lines primarily because of the ability to raise the insulation level of the lines by the use of wood in series with porcelain to reduce the phase to phase and phase to ground flashovers caused by lightning and switching surges. This type of wood construction, being less susceptible to electrical disturbances from lightning, improves the continuity of service and at the same time reduces the cost of transmission line construction.

Such wood transmission line supports for high voltage lines are generally of the so-called "H structure" type composed of two wood poles which support a horizontal cross-arm from which the transmission line conductors are suspended. Ordinarily such lines are protected from lightning by the use of overhead ground wires in which case, the poles extend above the crossarm with each pole top supporting an overhead ground wire. It is common practice to increase the stability and strength of such a structure by the use of "X braces" connecting the two poles below the crossarm.

Heretofore the crossarm, braces and overhead ground wire supports have been bolted to the wood poles. Consequently the wood poles and crossarm required holes drilled therein for the bolts, and usually portions of the pole (and of the crossarm if it too is round) were cut away to increase the area of contact of the adjacent parts. Such cut away portions of material are generally referred to as gains. Where heavy loads must be transmitted from one wooden member to another through a bolted connection, the bolt may crush the adjacent wood fibers or even cause the wooden member to split. Therefore, circular grooves were heretofore cut in the adjacent gains and steel timber connector rings inserted to provide additional bearing surface at the junction. Obviously the cutting of gains and grooves and the drilling of bolt holes materially reduce the bending strength of the wood members. Furthermore, bolt holes, grooves and flat wood surfaces in intimate contact retain moisture and encourage decay at the very place in the wooden member which has already been weakened. In addition the devices commonly used heretofore to attach the overhead ground wires to the pole tops utilized bolts through the pole in such a manner that the top of the pole might be split in the event of a broken wire.

Poles and crossarms are usually purchased with the gains, grooves and bolt holes cut by the vendor in order that all cutting operations will have been completed when the wood preservative is applied, and because this work can be done more economically in the vendor's pole yard than in the field. Pre-cut gains preclude the shifting of the crossarm on the structure and prevent the adjustment of the X brace attachment to plumb the structure after the poles have been set. Since the number of gains and their location on the pole or crossarm vary with different types of structures, the use of pre-cut gains or bolt holes makes it difficult to anticipate the proper combination of gains and bolt holes for each length of pole or crossarm which would be required at each shipping destination along a proposed line.

The junction of the pole and crossarm is particularly vulnerable to structure fires caused, under some conditions, by the leakage current which flows through the insulators, thence through the crossarm and pole to ground. The fire develops in that portion of the pole and crossarm which remains dry during a light rain or mist and is the result of concentrated I^2R loss in this small, high resistance area. The presence of the gains and through bolt facilitates the accumulation of heat until the wood is ignited. It would be desirable to prevent such fires caused by leakage currents by preventing the leakage current from passing through this dry area at the junction of the pole and crossarm.

It is believed that a lightning discharge to a pole will often travel over the surface of the pole to ground and that the presence of a bolt through the pole providing a metallic path to the interior will increase the probability of the pole being split or shattered by the stroke.

Furthermore, although the use of an X brace (or other equivalent type) on a two pole structure materially increases the transverse strength and permits longer spans, it has developed that the brace connects the poles in such a manner that a high velocity wind blowing across the line has the tendency to cause one of the poles to act as a fulcrum and to lift the other pole out of the ground. This action prevents the utilization of the full strength of the structure. Foundations for steel towers are designed to counteract this overturning action but, most H structure, wood pole lines, now being built, are not designed to counteract uplift.

Artificial foundations have been used under poles to prevent the poles from sinking in soft earth and devices have been attached to the bottom or butt end of poles to prevent the pole from being lifted as might be required on self-supporting structures at angles in a line. Most of the devices which have been used to prevent such vertical movement of the pole require the excavation by hand of large quantities of earth which is a costly operation. The excavation for pole settings is now commonly accomplished by the use of earth boring machines which produces a cylindrical hole of the proper depth. One method used hertofore of restricting the vertical movement of a pole without additional hand excavation involved the driving of railroad spikes around the butt of the pole and partially filling the hole with concrete after the pole had been erected. The cost of the concrete delivered as needed to the various structure sites makes this method impractical for general use on all structures of a transmission line.

Accordingly, it is an object of the present invention to provide a wood transmission line support which eliminates all gains and bolted connections or attachments with respect to the crossarms or portions of the poles above the ground line thereby avoiding a reduction in strength and the possibility of splitting of the poles or crossarms as a result of the bolts passing therethrough, provide means for horizontal or vertical adjustment of the crossarm on the structure, to provide means for the plumbing of a structure by shifting the X brace attachments and crossarms to simplify the ordering and distribution of poles and crossarms, to eliminate the possibilty of structure fires at the junction of the pole and crossarm caused by leakage currents, and to reduce the probability of the poles or crossarms being shattered by lightning.

It is a further object of the present invention to provide new and improved bearing plates which, when attached flush with the butt of the pole, restrict the vertical movement of the pole in either direction and still permit the use of a conventional earth boring machine for all excavation, do not interfere with the backfilling or tamping of the earth and, in addition, these bearing plates provide an effective ground electrode for the lightning protection facilities.

It is another object of the present invention to provide a wood transmission line support which eliminates all gains and bolt holes with respect to the cross arms or portions of the poles above the ground line.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claim annexed to and forming a part of this specification.

For a better understanding of the present invention reference may be had to the accompanying drawings in which

Fig. 1 is an elevational view of a wood H-structure transmission line support embodying the present invention;

Fig. 2 is a perspective view somewhat enlarged of a portion of Fig. 1;

Fig. 3 is an enlarged view of the portion between the lines X and Y of Fig. 1;

Fig. 4 is an enlarged sectional view taken at line 4—4 of Fig. 1;

Fig. 5 is an enlarged view taken on line 5—5 of Fig. 1;

Fig. 6 is an enlarged elevational view taken on line 6—6 of Fig. 1;

Fig. 7 is a perspective view of one of the bearing plates illustrated in Figs. 5 and 6; and

Figs. 8 and 9 are modifications of Fig. 2 illustrating a supporting means for one or more plank type cross arms.

Referring now to the drawings and particularly to Fig. 1 thereof, there is illustrated a transmission line support generally indicated at 10 comprising a two-pole structure including wood poles 11 and 12 having their lower ends embedded in the ground generally indicated at 13. These poles are mounted in spaced parallel relationship with the space between the poles generally being in excess of ten feet. For poles of the order of seventy feet in height it is common practice to have between eight and ten feet thereof embedded in the ground.

It is of course fundamental that the supporting structure of a transmission line should be capable of sustaining heavy overloads without permanent damage to any of its major necessary parts. Obviously the replacement of a pole such as 11 or 12 would require a long service interruption. If the supporting structure for the transmission line could be strengthened and the repair limited to the adjustment or replacement of a minor part, the reliability of the line would be greatly improved. In accordance with the present invention greatly improved performance is obtained by eliminating all gains and bolt holes in exposed portions of the poles and crossarms. As illustrated in Fig. 1, a suitable cross arm 14 disposed in a substantially horizontal plane is supported from the poles 11 and 12 near the upper ends thereof. The cross arm 14 is illustrated as of the "spar" type as distinguished from the "plank" type cross arm. This construction is preferable since it employs timber in its natural shape which is less expensive to begin with, is of greater strength than plank timbers and resists weathering to a greater degree. Unlike the plank construction it has no flat top surface nor large areas of intimate contact with other members. Both the flat top surface and large contacting areas are potential sources of decay. As is best shown in Fig. 2 of the drawings the cross arm 14 and the poles 11 and 12 are interconnected without the use of any bolt holes or without the cutting away of any wood material from any of the members. This is accomplished by clamps at each joint, each clamp comprising a pair of U-bolts 15 and 16 and a pair of clamp members 17 and 18 formed of semi-flexible material which readily conforms to the periphery of the pole. The ends of the clamp members 17 are provided with suitable openings for receiving the U-bolts 15 and 16 as is clearly shown in Fig. 2 of the drawings and the nuts 19 applied to the U-bolts provide the desired clamping force to maintain the parts in the assembled relationship shown.

It is apparent that with this construction the full strength of the wood members is retained with a substantial increase in strength over prior arrangements even neglecting the lowered tendency to decay. In addition, the junction of the pole and crossarm is protected from leakage current which in some circumstances, produces enough heat to cause a fire at a bolted connection. Furthermore, there is no metal path for lightning to enter a pole or arm which would facilitate the shattering of these wood members as would be the case with bolts extending through the pole and arm.

As is best shown in Fig. 1 of the drawings the crossarm 14 supports porcelain insulators designated at 20, 21 and 22 arranged in spaced relationship along the crossarm which insulators are adapted to support the three conductors 23, 24 and 25 respectively of a 3-conductor transmission line. The insulators 20 to 22 inclusive are suitably supported from the crossarm 14 by metal bands 26, which are clamped around the crossarm 14. Such metal bands provide a large area of metal in contact with wood to prevent leakage current burns. This construction again eliminates bolt holes and the consequent disadvantages.

For the purpose of increasing the strength of the structure particularly with reference to cross winds and the like, one or more X-braces are employed between the poles 11 and 12 below the crossarm 14. One such X-brace is shown in Fig. 1 and comprises a pair of wood members 27 and 28 which are crossed at their centers to form an X. A suitable clamping member 29 is provided to hold the center of the braces together as is shown in Fig. 1 of the drawings. The ends of these braces are attached to the poles 11 and 12 without the use of bolt holes through the poles and a preferred construction is illustrated in Fig. 3 of the drawings where each of the four ends of the X-braces to be attached to the poles 11 and 12 is provided with angle iron members 31 and 32 which are fastened as by bolts 33 so as substantially to surround the ends of the wooden members 27 and 28. A pair of spaced angular extensions 31*a* and 31*b* of the angle iron 31 provide a recess parallel with the pole for receiving one of a pair of clamping members 34 and 35 formed of semi-flexible material and adapted to partially surround the particular pole such as 12, illustrated in Fig. 3 of the drawings. The ends of clamp members 34 and 35 are partially sheared and pressed to form lugs as at 34*a* and 35*a* to provide means for the attachment of bent, threaded rods 36 and 37. Suitable nuts 38 applied to threaded ends of the rods 36 and 37 are adapted to clamp the members 34 and 35 to the poles such as 11 and 12. Lock nuts 39 may also be employed. For the purpose of fastening one of the clamping members such as 34 to the angle iron member 31 there is provided a bolt 40 provided with a cone shaped head 40*a* which is adapted to embed itself slightly in the wood of the associated pole such as 12. This bolt 40 has a square shoulder and is adapted to extend through aligned square openings in the extensions 31*a* and 31*b* and the interposed band or clamping member 34.

It is at once apparent that this construction has numerous advantages over the bolt and bolt hole arrangements used heretofore. It has been common practice for the vendor to supply poles with at least the top holes for the X-braces bored therein. In actual practice it was found that many times these holes were improperly bored or not bored at all thereby necessitating boring in the field. Also the bottom holes of the X-braces were bored in the field which required the contractor to carry an electric generator and an electric motor thereby adding materially to the construction operation as well as to the assembly operation. In addition, the structure is usually assembled on the ground and then erected and inserted into the holes in the ground which have been bored by an earth boring machine. It was common practice heretofore to have to lift the structure and adjust the depth of one of the holes in the ground so that the structure stands plumb. With the present invention this is unnecessary since the X-braces may be adjusted in any desirable manner by the clamping arrangement described and compensation for a few inches of variation of hole depth is automatically taken care of and in addition the requirement of bolt holes in the poles is completely eliminated.

In connection with high voltage transmission lines it is common practice to provide an overhead ground wire which ground wire is above the cross arm such as 14. Heretofore such overhead ground wires were often supported on a steel cross arm. Such steel cross arms are expensive and in the event of a broken ground wire were subject to substantial distortion. In accordance with the present invention the overhead ground wires such as is indicated at 41 in Fig. 4 of the drawings may be supported from each pole by suitable means entirely avoiding bolt holes in the pole. As illustrated a pair of semi-flexible clamping members 42 and 43 are provided the ends of which are formed into lugs indicated as 44. The clamps 42 and 43 are held in position by bent rods 45 and 46 which extend through the lugs 44 and to the threaded ends of which are applied suitable nuts 47 and 48. It should be noted that the clamp comprising the members 42, 43, 44, 45, 46, 47 and 48 is substantially identical with the clamp for fastening the ends of the X-brace to the poles, best shown in Fig. 3 of the drawings.

For supporting the ground wire such as 41 a rod 49 in the form of a loop is provided having its ends welded to the clamp 43. The rod 49 preferably supports a figure 8 twisted link 50 which serves as a flexible attachment for the suspension clamp 51, directly supporting the ground wire 41. It will be apparent that the overhead ground wire support of the present invention not only eliminates bolt holes but provides a clamp around the pole to prevent splitting thereof. For grounding the overhead ground wire at various points along the transmission line there are preferably provided suitable ground conductors such as 53 extending from the ground wire such as 41 to the base of the pole such as 11. As is best shown in Fig. 5 of the drawings the ground end of the ground conductor 53 is arranged in a spiral as indicated at 53*a* on the bottom surface of the pole. Suitable fastening means indicated at 55 hold the ground wire 53 in its proper position so as to come in contact with a maximum surface of the ground.

By virtue of the X-brace, the pole structure described above, when subjected to a strong cross wind tends to act as a lever with one of the poles serving as a fulcrum to lift the other pole out of the ground. In accordance with the present invention suitable means are provided to prevent or counteract this uplift action. Accordingly the base of each pole embedded in the ground is provided with bearing plates 57, two being shown in Fig. 5 of the drawings which are identical. As illustrated each bearing plate comprises a deformed angle iron member comprising a vertical flange 58 and a horizontal flange which is split to provide in effect two sections 59*a* and 59*b*. The vertical flange 58 is bent slightly to conform with the pole configuration. The horizontal flanges 59*a* and 59*b* of each bearing plate 57 have a substantial surface area for bearing against the soil to counteract vertical movement of the poles in either direction. To aid in attaching bearing plates 57 to the pole a vertically disposed angle iron 60 is provided. One of the flanges of the angle iron 60 is provided with a notch 60a for receiving the vertical flange 58 and the contacting portions of the vertical and horizonal angle irons are united as by welding or the like. The only bolt holes provided in the pole structure are those for accommodating a through bolt 61 for holding the bearing plates 57 in position. A plurality of recesses for lag screws 62 are also provided. However these openings in the poles are below the ground line and consequently of no disadvantage. For the purpose of reducing the ground resistance the end of the ground wire 53 is preferably attached to one of the bearing plates 57 as indicated at 64. An intermediate portion thereof is preferably also connected as indicated at 65 to the other bearing plate.

In view of the advantages of the "spar" type cross arm such as 14 set forth above it is considered the preferred arrangement. However, the present invention may also be employed for supporting plank crossarms without the use of bolt holes, gains or the like. In Fig. 8 a construction is illustrated whereby a pair of plank arms 70 and 71 are arranged on either side of the pole 11. Clamps 72 which may be identical with the clamps 17 and 18 described above are employed which substantially surround the pole and are clamped thereto by suitable rods 73 to which nuts 74 are applied in a manner clearly indicated in Fig. 8 of the drawings. The rods 73 are sufficiently long to extend beyond the planks 70 and 71 which in turn may be clamped to the pole 11 by suitable clamping plates 75 and nuts 76, both applied to the ends of the rods 73. If desired a suitable washer 77 having spikes or the like extending into the adjacent wood structure may be disposed between the planks 70 and 71 and the pole 11. It will be understood that the arrangement shown in Fig. 8 is equally applicable for supporting a single plank crossarm.

The arrangement disclosed in Fig. 9 for supporting a single plank crossarm will be obvious and the corresponding parts are designated by the same reference numerals as in Fig. 8. Instead of employing rods such as 73 bolts 80 are employed which extend through the openings in the ends of the clamping members 72. The clamping plates such as 65 and the nuts such as 76 insure satisfactory support of the plank crossarm 70. The arrangement disclosed in Fig. 9 is somewhat simpler than that disclosed in Fig. 8, but is more difficult to apply since the clamping to the pole 11 and the crossarm 70 is completed in one operation whereas with the arrangement in Fig. 8 the clamp is first applied to the pole and fastened thereto after which the crossarms 70 and 71 are clamped into position.

In view of the detailed description included above the operation of the transmission line support of the present invention will be apparent. It will furthermore be understood that with the present invention all gains are eliminated and no bolt holes above the ground line are required. Moreover, bearing plates are provided to prevent overturning of the structure as well as to reduce the ground resistance. The

assembly operation is considerably simplified and the full strength of all the wood parts is retained. Also by eliminating gains, timber ring grooves, and bolt holes decay of the wood structure is retarded. The presence of tight bands around the poles and crossarms tends to restore strength lost due to radial season craks. Lightning performance characteristics are also greatly improved without additional investment.

It will be apparent to those skilled in the art that the present invention is not limited to the particular arrangements and construction shown and described, but that changes and modifications may be made without departing from the spirit and scope of the present invention. It is aimed in the appended claim to cover all such changes and modifications.

What is desired to be secured by Letters Patent of the United States is:

A transmission line support comprising a pair of spaced vertically extending wood poles each having an end adapted to be embedded in the ground, said poles being imperforate and solid for at least the portion thereof disposed above ground, an imperforate wood cross arm extending between said poles, means for clamping each end of said cross arm to a different one of said poles by clamping means extending around but not through either the cross arm or said poles comprising a pair of U bolts and a pair of cooperating semi-flexible bands thereby eliminating bolt holes through either the cross arm or said poles and consequently greatly reducing damage to the poles or cross arm by lightning, and means for supporting a transmission line from said cross arm.

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