Jan. 12, 1965 J. KAMINSKI, JR., ETAL 3,165,284

MULTIPLE CONDUCTOR SUPPORT

Filed Nov. 21, 1963 5 Sheets-Sheet 1

Fig. 1.

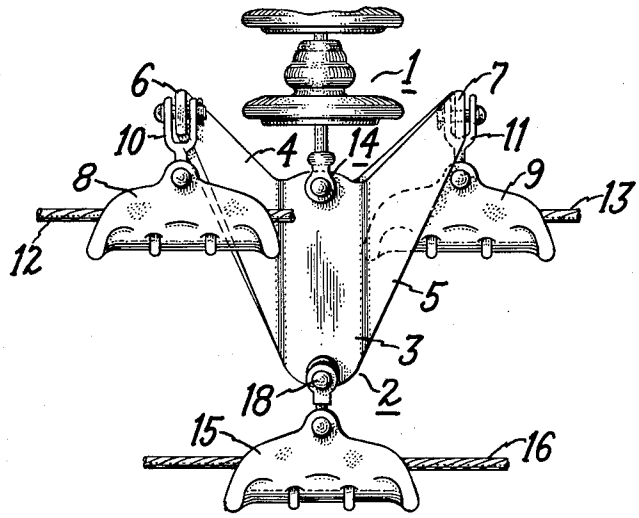


Fig. 2.

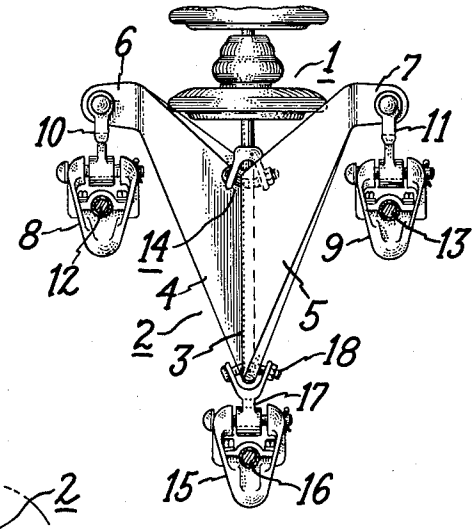
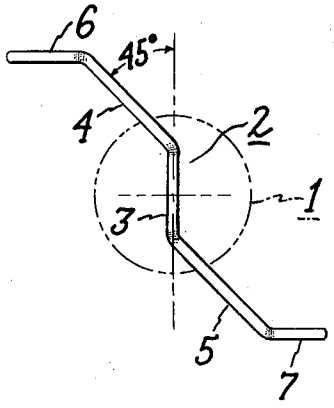


Fig. 3.



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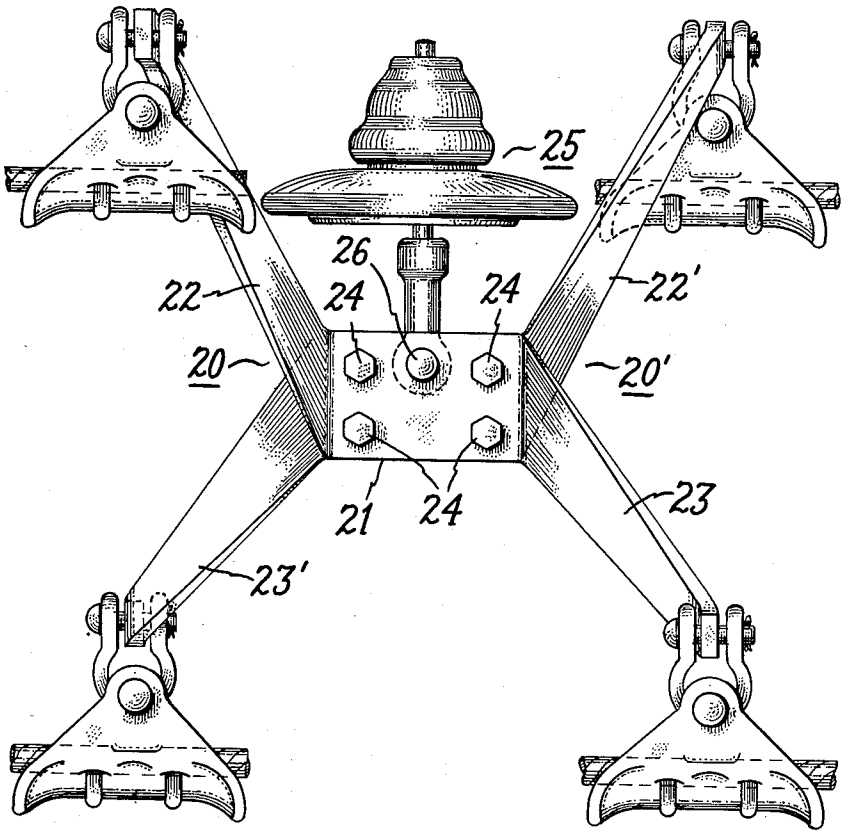
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MULTIPLE CONDUCTOR SUPPORT

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5 Sheets-Sheet 2

Fig. 4.



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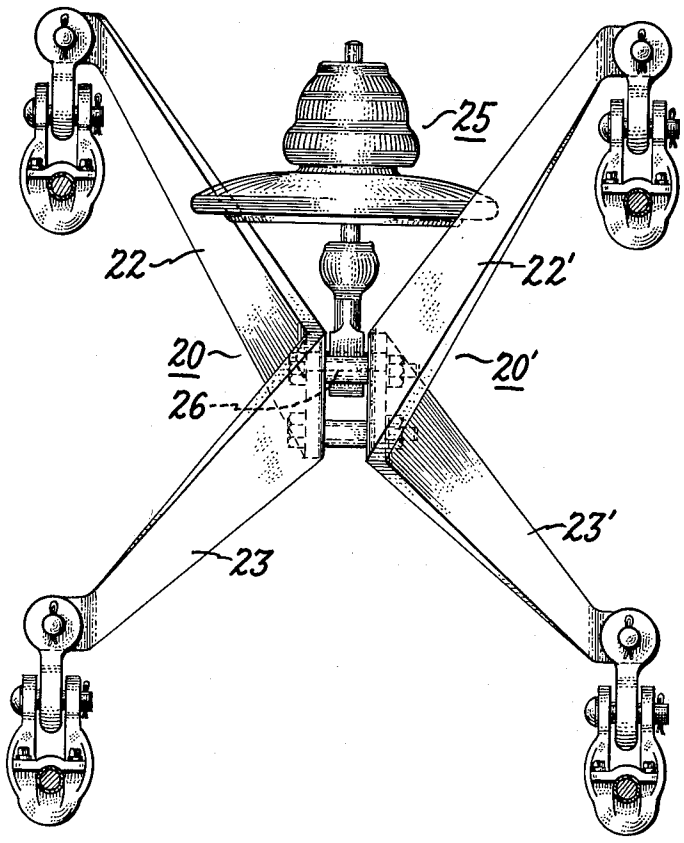
Jan. 12, 1965 J. KAMINSKI, JR., ETAL 3,165,284

MULTIPLE CONDUCTOR SUPPORT

Filed Nov. 21, 1963

5 Sheets-Sheet 3

Fig. 5.



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MULTIPLE CONDUCTOR SUPPORT

Filed Nov. 21, 1963

5 Sheets-Sheet 4

Fig. 6.

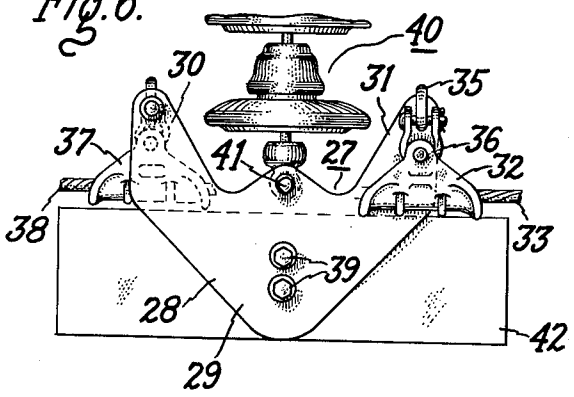


Fig. 7.

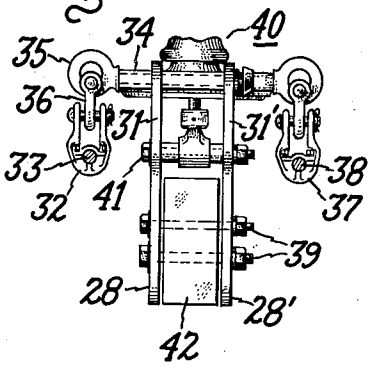


Fig. 8.

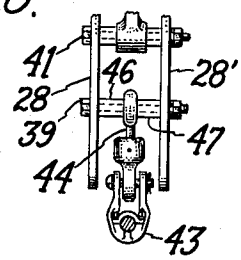


Fig. 9.

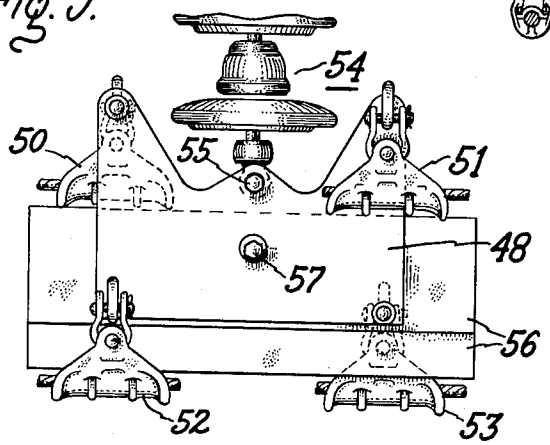
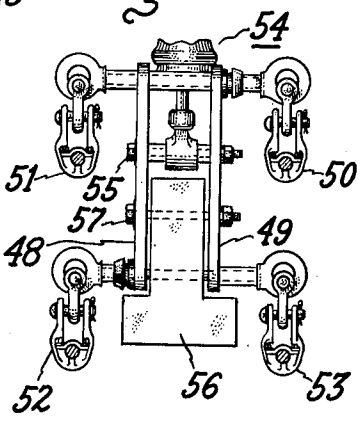


Fig. 10.



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Jan. 12, 1965 J. KAMINSKI, JR., ETAL 3,165,284
MULTIPLE CONDUCTOR SUPPORT
Filed Nov. 21, 1963 5 Sheets-Sheet 5

Fig. 11.

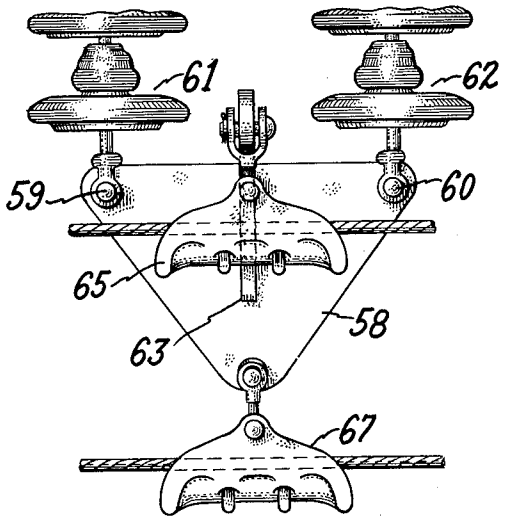
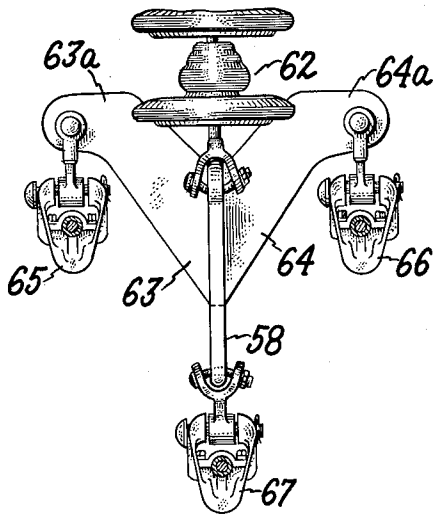


Fig. 12.



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United States Patent Office 3,165,284 Patented Jan. 12, 1965

3,165,284

MULTIPLE CONDUCTOR SUPPORT

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Filed Nov. 21, 1963, Ser. No. 325,358
16 Claims. (Cl. 248—63)

The present invention relates to multiple conductor supports, and more particularly to suspension equipment for electrical transmission lines having multiple conductors per phase.

In typical electrical transmission line support arrangements which are designed to carry a plurality of parallel conductors over long distances, one or more suspension insulator strings are suspended from tower cross arms and carry at their lower end a yoke member to which the parallel conductors are pivotally connected. Such an arrangement is shown, for example, in Kaminski et al. Patent 2,858,360.

In certain multiple conductor apparatus of this type, it has been found desirable to elevate some of the conductors above the junction of the insulator string and the yoke member so as to place them adjacent the lower insulator units of the suspension string. The purpose of this arrangement is to obtain some measure of shielding or stress-grading effects on the insulator string by the conductors adjacent thereto.

In prior apparatus of this type, the dimensions of the yoke structures and arrangements have been excessively large and have not been adapted to provide minimum spacing of the conductors supported thereby. The disadvantages of the prior constructions are that the electrical strike distance from the energized parts to the grounded tower uprights is reduced, and if the necessary distance is to be maintained, the tower cross arms must be longer, thus requiring more space for the overall transmission line supporting apparatus.

It is an object of the invention to provide a multiple conductor support arrangement which overcomes the above disadvantages of known types of support constructions.

It is another object of the invention to provide a conductor support apparatus of the above type having self-shielding characteristics, which provides for reduced spacing between the conductors, and in which the overall width of the assembly is no greater than approximately the conductor spacing.

It is still another object of the invention to provide a conductor support apparatus of the above type which is mechanically strong, is mechanically stable under operating conditions, is adaptable for use with 2, 3 or 4 conductors, and is readily and economically manufactured and assembled.

Other objects and advantages will become apparent from the following description and the appended claims.

With the above objects in view, the invention relates to supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper portion of the plate means for pivotally suspending the latter from the insulator, the connecting means having a pivot axis perpendicular to the plane of the plate means, the plate means having arm members projecting therefrom on opposite sides thereof which have extremities located above the connecting means, and conductor support means suspended from the extremity of each arm member for pivoting thereon about pivot axes perpendicular to the first-mentioned pivot axis and for carrying conductors parallel to the plane of the plate means.

The invention will be better understood from the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a side view of an embodiment of the invention adapted for carrying three conductors;

FIGURE 2 is an end view of the FIGURE 1 embodiment;

FIGURE 3 is a schematic plan view of the FIGURE 1 embodiment;

FIGURE 4 is a side view of a different embodiment adapted for supporting four conductors;

FIGURE 5 is an end view of the FIGURE 4 embodiment;

FIGURE 6 is a side view of another embodiment of the invention arranged for carrying two conductors;

FIGURE 7 is an end view of the FIGURE 6 embodiment;

FIGURE 8 is a fragmentary end view similar to that of FIGURE 7 showing a modification thereof;

FIGURE 9 is a side view of still another embodiment somewhat similar to that of FIGURE 6 but constructed for carrying four conductors;

FIGURE 10 is an end view of the FIGURE 9 embodiment;

FIGURE 11 is a side view of an embodiment of the invention adapted for use with two suspension strings and three conductors; and

FIGURE 12 is an end view of the FIGURE 11 embodiment.

Referring now to the drawings, and particularly to FIGURE 1, there is shown a three-conductor support assembly suspended from a single insulator string **1**. The support assembly comprises a yoke member **2** formed of a flat central plate **3** having arms **4** and **5** integral therewith (or rigidly connected thereto) projecting therefrom in opposite directions at angles of about 45° to the plane of central plate **3** and extending upwardly therefrom. Arms **4** and **5** are formed with integral end portions **6** and **7**, respectively, extending at right angles to the plane of central plate **3**, all as more clearly shown in the schematic plan view of FIGURE 3. As seen in FIGURE 2, cable clamps **8** and **9** are respectively pivotally suspended by means of links **10** and **11** from yoke arm portions **6** and **7**, so that conductors **12** and **13** carried therein are enabled to swing in an arc toward and away from yoke plate **3**. Clamps **8** and **9** are, in turn, pivotally secured to the lower ends of links **10** and **11**, respectively, as shown, for turning about pivot axes perpendicular to the axes of the pivots at the upper ends of links **10** and **11**.

The yoke assembly is suspended from insulator string **1** by a pivotal connection **14** at the upper portion of central plate **3**, wherein the pivot axis is perpendicular to the axes of the pivotal connections of links **10** and **11** with portions **6** and **7** of arms **4** and **5**.

Cable clamp **15** carrying a third cable **16** is secured to the lower portion of central plate **3** in substantial alignment with the upper pivot connection **14** by a pivot connecting means comprising link **17** and bolt **18**. Clamp **15** is thereby swingable about an axis parallel to that of pivot connection **14**. Cable **16** as thus arranged serves to stabilize the supporting assembly, especially under conditions which tend to displace the balanced position of the two upper cables with respect to pivot connection **14**.

As will be seen more clearly by reference to FIGURE 2, which is a view along the direction of the conductors, the described arrangement is such that the overall width of the supporting yoke assembly is no greater than approximately the spacing between the two outer conductors. It will also be evident that the provision for the yoke member **2** to pivot about an axis perpendicular to the pivoting axes of the cable clamps **8** and **9** results in avoiding interference of the cable clamps with the yoke member during swinging of the latter about its pivot connec-

tion 14, which otherwise would occur if the respective pivot axes were parallel to one another. The arrangement shown, therefore, makes it possible to space the conductors 12 and 13 closer together than would otherwise be feasible, thereby permitttting an overall reduction in lateral dimension of the supporting apparatus.

The arrangement of arms 4 and 5 at angles of about 45° to portion 3 as shown in FIGURE 3 is advantageous in that it contributes to a saving of material as compared to an arrangement wherein the arms project initially in the plane of central portion 3 and then extend at right angles to the latter to locate their extremities 6, 7 in the positions shown in FIGURE 3.

FIGURES 4 and 5 show a modified arrangement adapted for supporting four conductors in stabilized position. The supporting structure of this embodiment comprises a pair of identical yoke members 20 and 20', each being formed of a central yoke plate 21 having arms 22 and 23 at opposite ends projecting from the same side thereof in directions at 45° to the plane of yoke plate 21, one arm 22 being inclined upwardly and the other arm 23 being inclined downwardly.

As shown in FIGURE 5, the two yoke members 20, 20' are secured together with their central yoke plates parallel to each other, and with the arms of the respective yoke members extending away from each other on opposite sides of the assembly. The outer extremity of each arm is bent so as to provide a bearing portion lying at right angles to the plane of the central yoke plates, and from each bearing portion a cable clamp carrying a conductor is pivotally connected, substantially as described and shown in connection with the upper cable clamps of the FIGURE 1 embodiment.

Yoke members 20, 20' are joined in spaced relation by a plurality of bolts 24, and the assembly is suspended from insulator string 25 by pin 26 which provides for pivoting of the yoke assembly about an axis perpendicular to the pivot axes of the suspended conductors on the bearing portions of arms 22, 23, 22', 23'. In this arrangement, the disposition of the four conductors as described results in a stabilized and balanced position of the assembly, and as in the previously described embodiment the improvement of reduced spacing of the conductors and width of the yoke assembly is achieved in similar manner.

FIGURES 6 and 7 show a form of the apparatus which is adapted for carrying 2, 3 or 4 conductors in stable position. The support yoke 27 comprises a pair of identical yoke plates 28, 28' fastened together in spaced parallel relation, each plate having a central portion 29 and arms 30, 31 extending upwardly at opposite ends thereof. Cable clamp 32 carrying cable 33 is pivotally connected to the support yoke by means of pin 34 passing through the opposed arms 31, 31' and having a ring member 35 at one end from which is suspended shackle 36 carrying cable clamp 32. As will be understood, cable clamp 37 carrying the second conductor 38 is pivotally supported by similar means from the other opposed arms (of which only arm 30 is visible in FIGURE 6) so as to be suspended on the opposite side of the yoke assembly from clamp 32, as shown in FIGURE 7, and spaced longitudinally away from clamp 32, i.e., in the direction of the conductors, as shown in FIGURE 6. The yoke assembly 27 is suspended from insulator string 40 by pivot connection 41 to permit turning of the yoke assembly about a pivot axis perpendicular to the pivot axes of the clamp suspension means, as in the previously described embodiments. Where only two conductors are supported as shown, a weight 42 of suitable size and form is arranged between the yoke plates 28, 28' at the lower portions thereof and secured by bolts 39, for insuring adequate stabilization and balance in the supporting apparatus.

As shown in the fragmentary view of FIGURE 8, the FIGURE 7 device may be readily converted to a three-conductor support by removing weight 42 and replacing it with another conductor clamp. In the illustrated device, this is achieved by removing one of the bolts 39 used to secure the weight, and suspending a third conductor clamp 43 by means of ball and socket link 44 having an eye portion 44*a* from the remaining bolt 39, and with suitable spacers 46, 47 added to properly position link 44.

The double yoke plate of this embodiment, and the FIGURE 9 embodiment described below, not only makes the device readily adaptable to the alternative arrangements shown, but also contributes increased mechanical strength to the support assembly to resist the twisting stresses exerted thereon by the supported conductors under operational conditions.

FIGURES 9 and 10 show a double yoke plate embodiment for carrying four conductors. In this device, parallel yoke plates 48, 49 are employed which are similar in form to the plates of the FIGURE 6 embodiment except that the lower portions of plates 48, 49, instead of being V-shaped as in the FIGURE 6 device, are substantially rectangular to accommodate the securing means of the two lower cable clamps. All the cable clamps 50, 51, 52, 53 are pivotally suspended from pins passing through both plates, substantially as described in connection with clamps 32 and 37 in the FIGURE 6 embodiment. For proper balance, the cable clamps are arranged in staggered relation as shown. Thus, upper cable clamp 51 is spaced from lower cable clamp 52 in the longitudinal direction, i.e., along the direction of the conductors, while upper cable clamp 50 on the other side of the assembly is longitudinally spaced from lower cable clamp 53. As shown, each pair of clamps 51, 53 and clamps 50, 52, respectively, are substantially aligned in a transverse direction.

The yoke assembly is suspended from an insulator string 54 by a pivotal connection 55 at the upper central portions of the yoke plates, as in the FIGURE 6 embodiment, so that the yoke plate assembly may swing in its plane about the axis of pivot 55 perpendicularly to the axes of the suspension pivots of the four cable clamps.

Between the lower portions of yoke plates 48, 49 weight 56 is secured by means of bolt 57, as well as by the pins from which the lower clamps 52, 53 are suspended. The provision of such a weight, even with the stabilizing effect of the two lower cables, is often desirable where added downwardly directed forces are required to counteract uplift forces acting on the insulator string. Such uplift forces may be encountered, for example, on that part of a transmission line suspension support system which is located in a valley with the adjacent transmission towers located on elevated ground.

As will be evident, the FIGURE 9 embodiment is readily adaptable not only as a four conductor support with a weight as shown, but also as a four conductor support without a weight, or a three-conductor support with the third conductor replacing the weight, or a two conductor support with a weight. The spaced double plate arrangement also makes it possible to employ weight members of any desired length between and projecting symmetrically beyond the plates to add the necessary amount of stabilizing weight without interfering with the remaining support components or making the device excessively cumbersome.

FIGURES 11 and 12 show an embodiment of the invention adapted for use with two insulator suspension strings. This modification comprises a substantially triangular yoke plate 58 with downwardly directed apex and with connections 59, 60 at opposite upper corners for pivotal suspensions from two insulator strings 61, 62. Extending upwardly and outwardly from the central portion of plate 58 on opposite sides thereof are arms 63, 64 which project at right angles to the plane of plate 58. Arms 63, 64, which are welded or otherwise suitably rigidly secured at their base portions to plate 58, are formed at their upper extremities with bearing portions 63*a*, 64*a* respectively, from which are pivotally suspended cable clamps 65 and 66 for swinging about pivot axes perpendicular to the pivot axes of insulator connections

59 and 60, in a manner similar to that of the previously described embodiments. Suspended from the lower portion of plate 58 is a third conductor clamp 67 which is pivotally secured to the plate similarly to clamp 15 of FIGURE 2.

While the two insulator strings, 61, 62 are shown as hanging vertically, it will be understood that the strings may be so attached at their upper ends (not shown) that they converge substantially in the same plane toward their connection with yoke plate 58 to form a so-called "V-string" arrangement.

There is thus provided by the invention a multiple conductor support arrangement which is adaptable for use with 2, 3 or 4 conductors wherein the conductors are arranged to provide shielding effects for the insulator strings, which is characterized by minimum width of the support structure coupled with close spacing of the supported conductors, which permits relative movement of the supporting yoke and the conductors without interference from one another, and which is adapted to resist mechanical stresses during operational use.

While the present invention has been described with reference to particular embodiments thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the scope of the invention. Therefore, the appended claims are intended to cover all such equivalent variations as come within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means having arm members projecting therefrom on opposite sides thereof, said arm members having extremities located above said connecting means, and conductor support means suspended from the extremity of each said arm member for pivoting thereon about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means.

2. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means having arm members projecting therefrom on opposite sides thereof, said arm members having extremities located above said connecting means, conductor support means suspended from the extremity of each said arm member for pivoting thereon about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means, and stabilizing means secured to the lower portion of said plate means.

3. Supporting apparatus as defined in claim 2, wherein said stabilizing means comprises means for supporting at least one electrical conductor.

4. Supporting apparatus as defined in claim 2, wherein said stabilizing means comprises a weight member.

5. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means having arm members projecting symmetrically therefrom on opposite sides thereof at angles substantially less than 90° to the plane of said plate means, said arm members having extremities located above said connecting means and extending substantially perpendicular to said plate means, conductor support means suspended from the extremity of each said arm member for pivoting thereon about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means, and stabilizing means secured to the lower portion of said plate means.

6. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper central portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means having arm members projecting symmetrically therefrom on opposite sides thereof at angles of about 45° to the plane of said plate means, said arm members having extremities located above said connecting means and extending substantially perpendicular to said plate means, conductor support means suspended from the extremity of each said arm member for pivoting thereon about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means, and stabilizing means secured to the lower central portion of said plate means.

7. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means having oppositely directed faces and having two arm members projecting outwardly from each face on opposite sides of said connecting means, one of said arm members being inclined upwardly and the other being inclined downwardly, the upwardly inclined arm member of each face being located on the same side of said connecting means as the downwardly inclined arm member of the opposite face, said arm members having extremities spaced from said plate means, the extremities of the two upwardly inclined arm members being located above said connecting means, and conductor support means suspended from the extremity of each arm member for pivoting about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means.

8. Supporting apparatus as defined in claim 7, wherein said plate means comprises a pair of plate portions rigidly secured together in parallel spaced relation, and said connecting means comprises a connecting link arranged between and pivotally secured to said spaced plate portions.

9. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper central portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means having oppositely directed faces and having two arm members projecting outwardly from each face on opposite sides of said connecting means, the arm members of each face diverging from one another and being at angles substantially less than 90° to the plane of said plate means, one of said arm members being inclined upwardly and the other being inclined downwardly, the upwardly inclined arm member of each face being located on the same side of said connecting means as the downwardly inclined arm member of the opposite face, said arm members having extremities spaced from said plate means, the extremities of the two upwardly inclined arm members being located above said connecting means, and conductor support means suspended from the extremity of

each arm member for pivoting about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means.

10. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper central portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means having oppositely directed faces and having two arm members projecting outwardly from each face on opposite sides of said connecting means, the arm members of each face diverging from one another and being at angles of about 45° to the plane of said plate means, one of said arm members being inclined upwardly and the other being inclined downwardly, the upwardly inclined arm member of each face being located on the same side of said connecting means as the downwardly inclined arm member of the opposite face, said arm members having extremities spaced from said plate means, the extremities of the two upwardly inclined arm members being located above said connecting means, and extending substantially perpendicular to the plane of said plate means, and conductor support means suspended from the extremity of each arm member for pivoting about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means.

11. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means comprising a pair of plate members rigidly secured together in parallel spaced relation, each plate member having an arm member projecting outwardly therefrom with an extremity located above said connecting means, said arm members being arranged on opposite sides of the axis of said connecting means, conductor support means suspended from the extremity of each said arm member for pivoting thereon about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means, and stabilizing means arranged between said plate members at the lower portion thereof.

12. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means comprising a pair of plate members rigidly secured together in parallel spaced relation, each plate member having an upper arm member and a lower arm member projecting outwardly therefrom on opposite sides of the axis of said connecting means, the extremities of the upper arm members being located above said connecting means, and conductor support means suspended from the extremity of each said arm member for pivoting there. on about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means.

13. Supporting apparatus for suspending a plurality of electrical conductors from an insulator comprising, in combination, plate means having upper and lower portions, connecting means at the upper portion of said plate means for pivotally suspending said plate means from the insulator, said connecting means having a pivot axis perpendicular to the plane of said plate means, said plate means comprising a pair of plate members rigidly secured together in parallel spaced relation, each plate member having an upper arm member and a lower arm member projecting outwardly therefrom on opposite sides of the axis of said connecting means, the extremities of the upper arm members being located above said connecting means, conductor support means suspended from the extremity of each said arm member for pivoting thereon about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means, and stabilizing means arranged between said plate members at the lower portions thereof.

14. Supporting apparatus for suspending a plurality of electrical conductors from a pair of spaced insulator strings comprising, in combination, plate means having upper and lower portions and opposite end portions, separate connecting means at the upper opposite end portions of said plate means pivotally suspending said plate means from the spaced insulator strings, each said connecting means having a pivot axis perpendicular to the plane of said plate means, arm members projecting upwardly and outwardly from opposite sides of said plate means and having extremities located substantially above said connecting means, and conductor support means suspended from the extremity of each said arm member for pivoting thereon about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means.

15. Supporting apparatus for suspending a plurality of electrical conductors from a pair of spaced insulator strings comprising, in combination, plate means having upper and lower portions and opposite end portions, separate connecting means at the upper opposite end portions of said plate means pivotally suspending said plate means from the spaced insulator strings, each said connecting means having a pivot axis perpendicular to the plane of said plate means, arm members projecting upwardly from the central portion of said plate means substantially at right angles thereto and having extremities located above said connecting means, conductor support means suspended from the extremity of each said arm member for pivoting thereon about a pivot axis perpendicular to said first-mentioned pivot axis and for carrying conductors parallel to the plane of said plate means, and stabilizing means secured to the lower portion of said plate means.

16. Supporting apparatus as defined in claim 15, wherein said stabilizing means comprises means for supporting another electrical conductor.

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