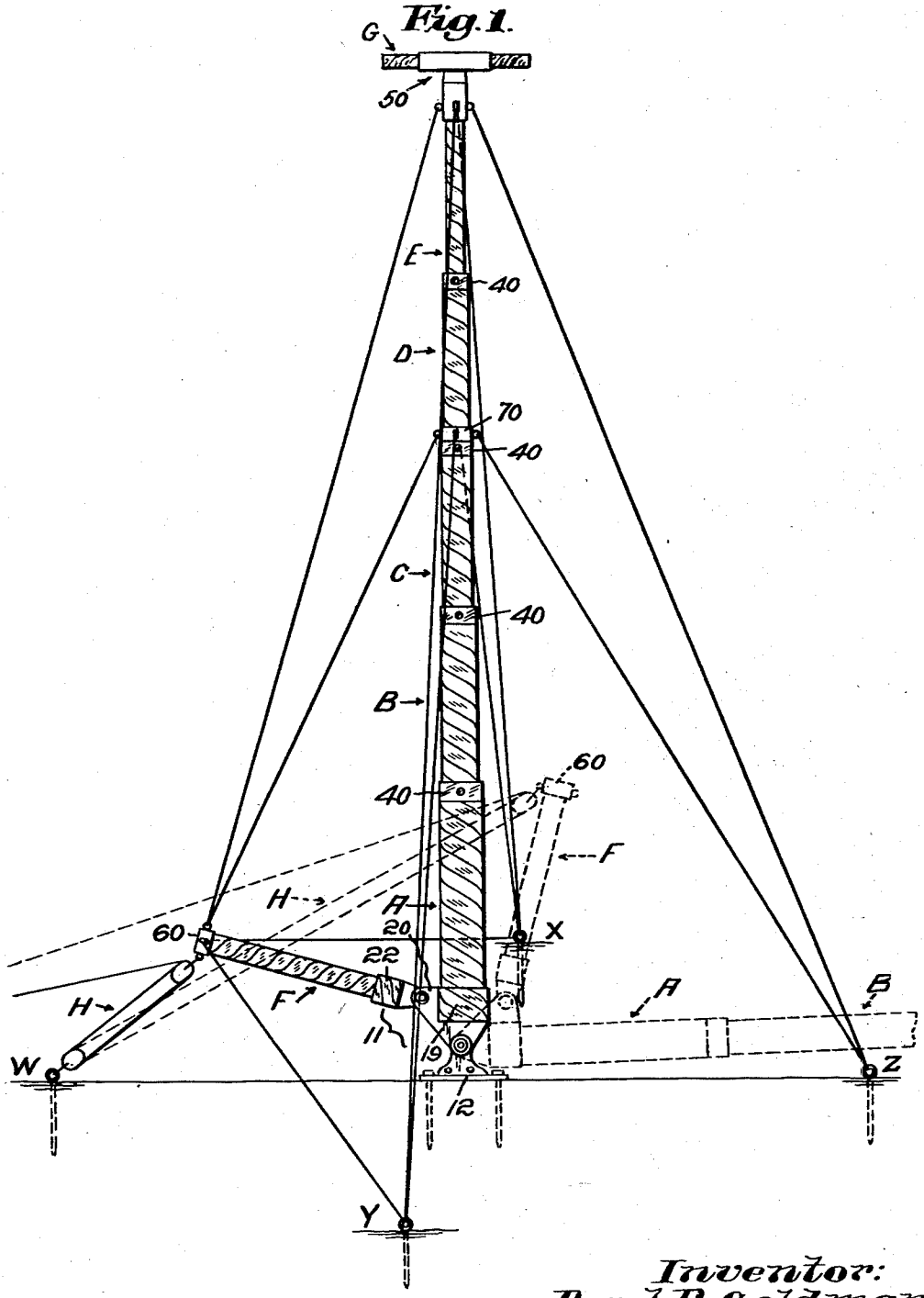
Dec. 17, 1946. P. R. GOLDMAN 2,412,678

TELESCOPIC, TUBULAR PLYWOOD MAST AND METHOD OF MAKING THE SAME

Filed Aug. 21, 1943 4 Sheets-Sheet 1

Fig. 1.



Inventor:
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Attys

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TELESCOPIC, TUBULAR PLYWOOD MAST AND METHOD OF MAKING THE SAME

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Fig. 2.

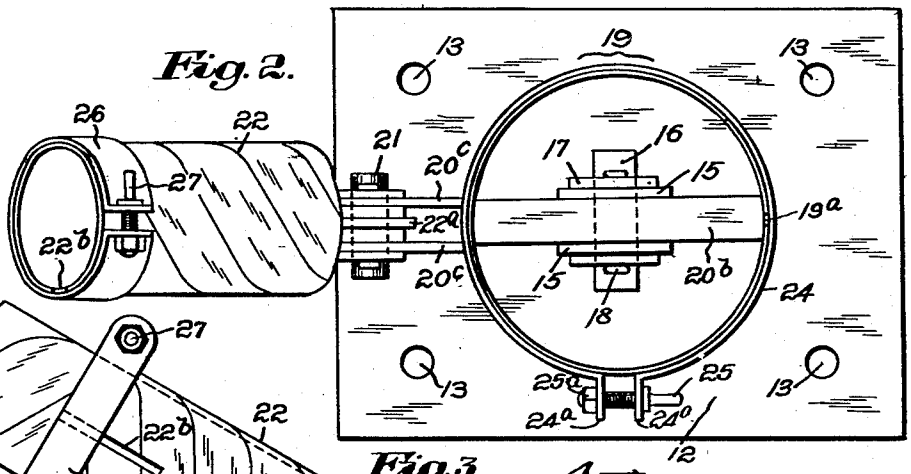


Fig. 3.

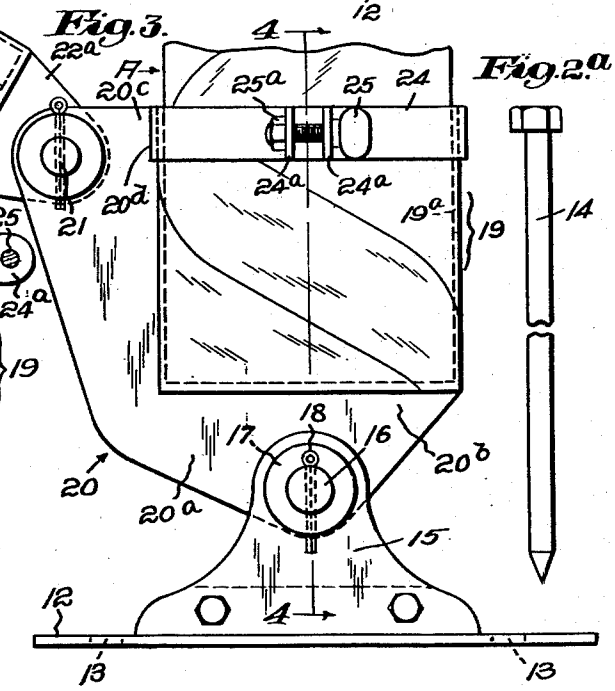


Fig. 2a.

Fig. 4.

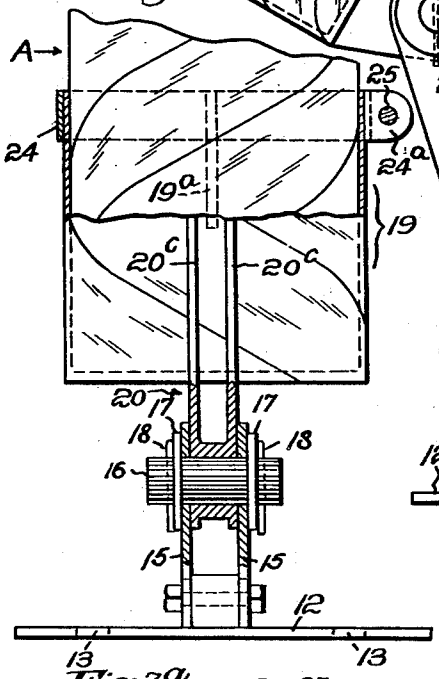
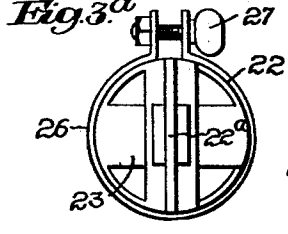


Fig. 3a.



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TELESCOPIC, TUBULAR PLYWOOD MAST AND METHOD OF MAKING THE SAME

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Fig. 5.

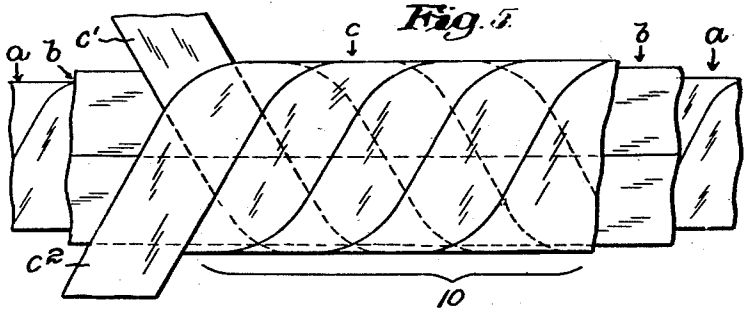


Fig. 6.

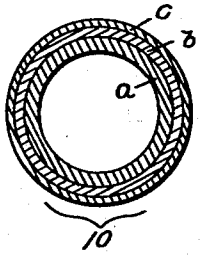


Fig. 7.

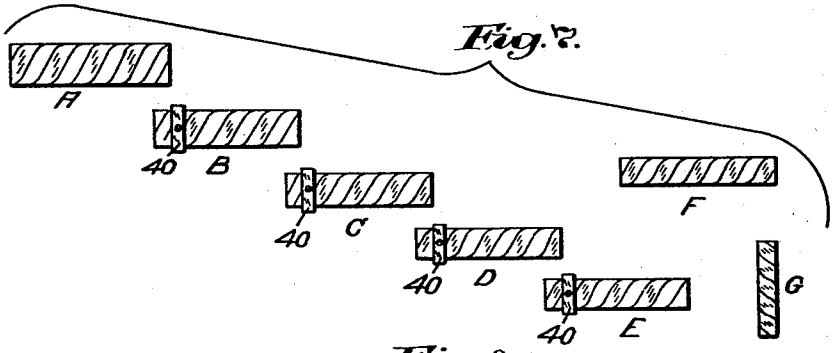


Fig. 8.

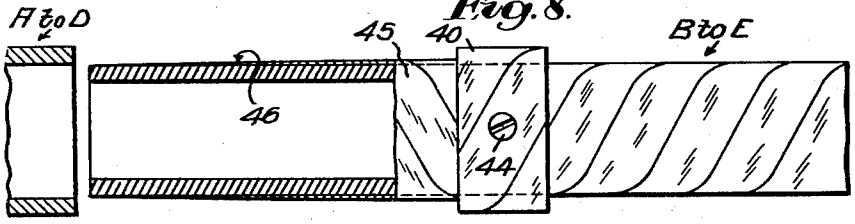
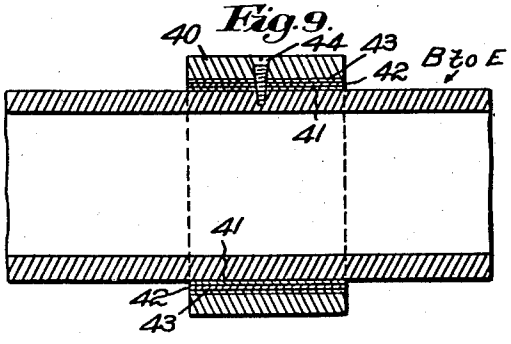


Fig. 9.



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TELESCOPIC, TUBULAR PLYWOOD MAST AND METHOD OF MAKING THE SAME

Filed Aug. 21, 1943 4 Sheets-Sheet 4

Fig. 10.

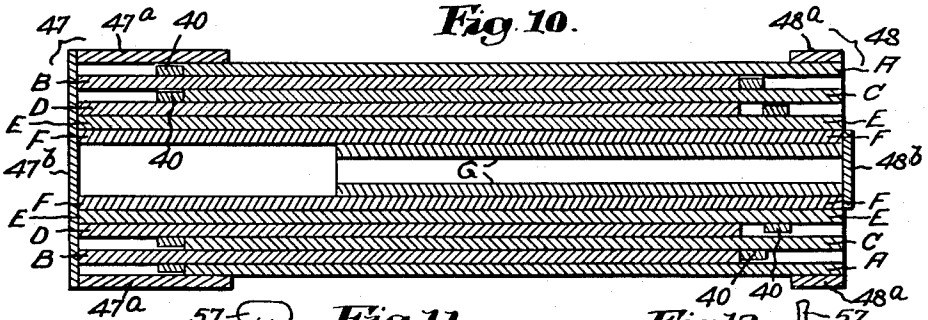


Fig. 11.

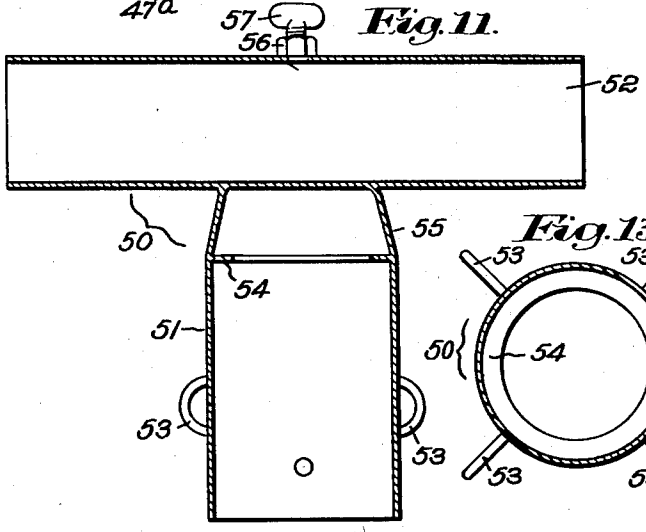


Fig. 12

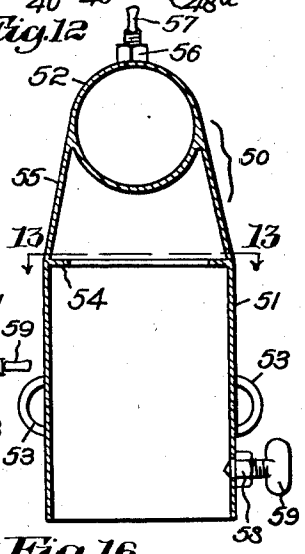


Fig. 13.

Fig. 14

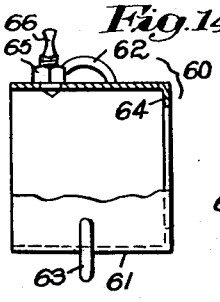


Fig. 15

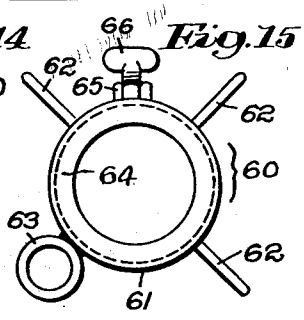


Fig. 16

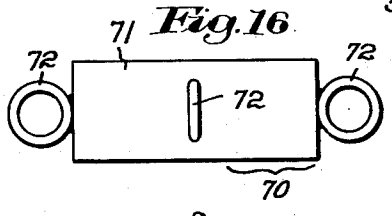


Fig. 17.

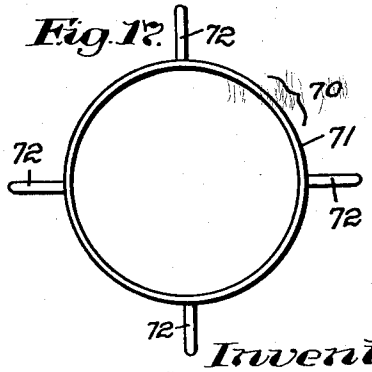
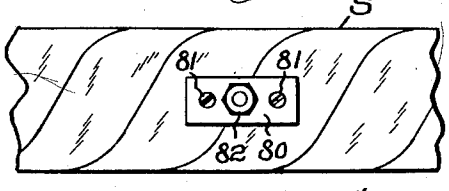


Fig. 18.



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Patented Dec. 17, 1946

2,412,678

UNITED STATES PATENT OFFICE

2,412,678

TELESCOPIC, TUBULAR PLYWOOD MAST AND METHOD OF MAKING THE SAME

Paul R. Goldman, Andover, Mass., assignor to Plymold Corporation, Lawrence, Mass.

Application August 21, 1943, Serial No. 499,573

4 Claims. (Cl. 20—99)

1

This invention relates to portable masts and mast assemblies particularly for the support of radio antennae but adaptable to other purposes, and to their manufacture, packaging, transport and erection for use. It aims to provide for such masts a sectional formation comprising separable tubular elements adapted for lengthwise assembly and also for nesting or telescoping one into another, generally together with other tubular parts, to compact them into a transporting package of minimum length, cubic content and weight for a mast of given height. Among the important objects of the invention is the adaptation of a wound and bonded wood veneer or plywood construction to all main tubular elements of such mast and assembly, including not only the sections of the mast proper but also certain accessory parts such as an incorporated erecting boom, holding means for the mast and the boom, and if desired a cross arm, all elongated elements save possibly for some of them in the exceedingly long installations such as ninety feet or more being arranged for compactly telescoping into a single unit package. Under the invention other accessory elements preferably also are of plywood, and the entire unitary equipment is constructed and arranged for rapid and easy unpacking at the place of use, and for assembly and anchorage in a substantially horizontal assembling position of the mast proper wherein all points upon it are readily accessible, the mast then being easily manually erectible to vertical use position by one person.

In order that the principle of my invention may be readily understood, I have in the accompanying drawings illustrated certain embodiments thereof, to which my invention is not limited, and which, though specifically described, are intended as exemplary only.

In the drawings:

Fig. 1 is a somewhat diagrammatic representation, not to scale, of a typical mast assembly in erected or use position, in full line, a preparatory or assembling position being indicated in dotted line;

Fig. 2 is a plan view of the base assembly comprising a base plate and pivotally associated mast and boom cylinders or holders;

Fig. 2a shows one of the base plate pins;

Fig. 3 is a side elevation of the base assembly of Fig. 2;

Fig. 3a is a bottom end elevation of one member of the base assembly, namely the boom cylinder or holding socket;

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Fig. 4 is a view mainly in vertical section on the line 4—4 of Fig. 3;

Fig. 5 illustrates in elevation a relatively short length of the typical multiple-ply wound and bonded wood veneer or plywood structure for the elongated tubular sections and elements such as the mast proper, the boom and any cross-arm, and also for the cylindrical holders;

Fig. 6 is a partly diagrammatic cross-section through a typical tubular plywood structure such as that of Fig. 5;

Fig. 7 is a diagrammatic lay-out of the tubular plywood sections for a five-piece mast, such for example as of fifty-foot or other length, including the boom and a cross-arm, such as in Fig. 1;

Fig. 8 is a longitudinal sectional view showing two next adjacent tubular wound plywood sections with the positioning ring, sleeve or collar secured in place on the section of smaller diameter;

Fig. 9 is a longitudinal sectional view, on a somewhat larger scale, of a portion of a tubular plywood section adjacent and including the positioning ring, sleeve or collar;

Fig. 10 is a longitudinal section of the package or shipping unit comprising the several nested or telescoped sections and elements;

Fig. 11 is a vertical cross-section of a cross-arm support which may be employed at the top of the mast;

Fig. 12 is a vertical central section upon Fig. 11;

Fig. 13 is a horizontal section as on the line 13—13 of Fig. 12;

Fig. 14 is a side elevation, partly in section, of the boom stay collar;

Fig. 15 is a top or outer end elevation of said collar of Fig. 14;

Figs. 16 and 17 are respectively a side elevation and a plan view of a mast stay collar; and

Fig. 18 is an elevational detail view showing a modified form of securing means upon a tubular plywood element.

The structural character of a majority of the tubular and hollow cylindrical elements of the mast assembly as a whole, being essentially involved in and largely contributing to the present invention, will now be described by way of introduction to a more detailed consideration of the component parts of the mast and accessory equipment and the methods of forming, packaging and setting up the same for use.

For the purposes of such description reference is made to my copending application Ser. No. 467,243, filed November 28, 1942, now Patent No. 2,352,533, issued June 27, 1944, which I hereby

make a part of the present disclosure as to the construction of the several tubular and hollow cylindrical members later herein identified, by preparing, winding and bonding together a multiplicity of layers or plies of wood veneer stripping or plywood.

By way of sufficient disclosure in the present application, Figs. 5 and 6 hereof represent somewhat diagrammatically an indeterminate length 10 of such multiple-ply bonded wood veneer or plywood tubing. In said views, space and drafting limitations prevent the indication of all individual plies of the groups or strata thereof, and thickness dimensions are exaggerated or are not to scale. This tubing structure characteristic of the invention comprises a number of concentric layers or ply groups such as *a*, *b* and *c* each in turn made up of a plurality of windings or wrappings of thin wood veneer such as c^1 and c^2 of Fig. 5, sometimes with one or more interposed thin metallic or metal foil layers, all plastically bonded together under heat or pressure or both into a unitary tubular structure of light weight and of great strength and rigidity both radially and axially.

As more fully described in said prior application, an inner or core stratum or ply-group *a*, Figs. 5 and 6, is formed by a plurality of relatively narrow elongated veneer or plywood strips wound in edgewise abutment in an advancing cylindrical spiral or helix and with the individual wood plies oppositely alternated in wind direction and having their grain predominantly along the line of the spiral wind. The successive ply windings have between them a layer or coating of a suitable bonding and integrating agent preferably of the thermosetting or polymerizable type such as an urea formaldehyde or other plastic cementitious or adhesive agent.

Around such plural-ply initial or core stratum *a* is formed a longitudinal strengthening and rigidifying stratum *b*, itself composed of two or more plywood or wood veneer plies applied as by straight-on or convolute winding or otherwise so as to present the wood grain predominantly lengthwise of the structure, that is, in general parallelism with the tubing axis. These longitudinal applications are similarly interbonded with each other and to the core *a* as are the individual plies of the latter. Over the resulting plural-strata body *a*—*b* there desirably is furnished an outer or covering stratum *c*, again preferably composed of two or more windings of the veneer stripping wrapped spirally in alternately opposite directions. The resulting tubular or hollow cylindrical structure, the outer, inner and other portions of which may be impregnated or otherwise treated to render them additionally weather- and water-proof, is a substantially homogeneous tubing unit having hard and wear-resistant surfaces and a high total radial and axial rigidity in consideration of its lightness in weight per unit of given size and length.

It will be understood that the described tubing is wholly or mainly non-metallic, save in some instances for one or more thin or foil-like metallic layers incorporated at any convenient position, for electronic or other purposes, as for example in another of my copending applications Serial No. 476,690, filed February 22, 1943, and that it is fabricated in indeterminate lengths, of any required diameter, total wall thickness and cross-sectional shape, although generally cylindrical as illustrated.

Turning now more particularly to the mast assembly and equipment as fabricated from the described tubular plywood in further accordance with the present invention, Fig. 1 shows somewhat diagrammatically an exemplary embodiment thereof, in assembled and erected or use position. The several component parts or elements will first be generally identified and then described in more detail.

As here shown for illustrative purposes these comprise (1) a base assembly, all of which, with exceptions to be noted, may be of plywood including the flat or molded parts as well as the hollow cylindrical members; (2) the telescopic tubular plywood mast proper and its like-formed erecting boom; (3) stay collars for the mast and the boom, those for the mast depending in number on the overall height or length of the particular mast; (4) a cross-arm assembly, which may be omitted in some types of masts; and (5) the packaging means or shipping caps for the package or transporting unit generally comprising the nested or telescoped mast and boom sections and the cross-arm when employed.

The general manner of assembly and erection of the mast equipment will readily be understood by reference to Fig. 1. The base assembly there indicated generally at 11 is set at any point selected for erection of the mast, with its base plate flat upon the ground or other supporting surface and secured in position as by the indicated spikes (see Fig. 2*a*).

Initially, for the purposes of assembly and erection, the mast cylinder or socket 19 of the base assembly is turned down into the substantially horizontal position as indicated in dotted lines at the lower right in Fig. 1, the boom cylinder or socket 22 then being above the mast cylinder. The first or lowermost section A of the mast, of largest diameter, has one end inserted into and secured in the mast cylinder. The several other tubular plywood sections of the mast such as B, C, D and E are successively interfitted endwise by positioning of their inserting ends into the receiving ends of the preceding section of next larger diameter. The erecting boom F is similarly fitted into its cylinder or socket on the base assembly, with its stay collar 60 fitted upon its outer end. Any intermediate stay collar for the mast, such as indicated at 70 just above the mast section C in Fig. 1, is installed, as also the stay attaching means for the mast top in Fig. 1. Where the mast is of the type including a cross-arm assembly G, such top stay collar may be incorporated with the cross-arm support 50, being so represented in Fig. 1, in other instances a top stay collar generally similar to that for the boom being employed. These stay collars or the like are provided with angularly spaced means for the attachment of stay wires or guy ropes as at the four quadrants of the mast, in the 12, 3, 6 and 9 o'clock positions respectively.

Angularly corresponding anchor points are selected upon the ground. Three of these are indicated at X, Y and Z in Fig. 1, being substantially equally radially spaced from the mast base, as about 20 feet from it for a 50-foot mast, any suitable anchoring means being employed such as the eye-pins indicated in Fig. 1. It will be understood that as viewed in Fig. 1 one such anchor point, as the point Z, is approximately in line with and below the mast in its substantially horizontal assembled but non-erected dotted-line position. The pair of diametrically opposed anchor points X and Y, each approximately 90° from point Z, would actually in the position of

Fig. 1 come substantially in line with the erected mast as there shown, but for the sake of clearness in illustration, such anchorages X and Y are shown set out slightly to the right and left respectively.

At the fourth quadrant, substantially opposite the line of the non-erected mast in its horizontal or flat dotted line position of Fig. 1, a boom anchor point is provided as at W, preferably spaced radially a less distance from the base of the mast than the other anchorages, for example 14 to 15 feet or thereabouts in the case of the 50-foot mast installation mentioned.

Before erection of the mast, its intermediate and upper stay-receiving means are connected by the indicated stays or guys of Fig. 1 with the corresponding anchor points, substantially in the manner there indicated. One such stay-receiver or eye of the boom stay collar 60 is similarly stayed to the mast and its two next adjacent and mutually opposite eyes are stayed respectively to the corresponding radially opposite anchor points X and Y. The remaining attaching point of the boom stay collar is connected to the boom anchor point W by the block-and-tackle means illustrated diagrammatically at H. The boom and the block-and-tackle prior to erection of the mast assume a general position substantially as represented in the dotted lining of Fig. 1.

One person hauling upon the block-and-tackle may then easily and quickly raise the mast to and secure it in its erected position of the full lining of Fig. 1, as will readily be apparent from a consideration of that figure.

Base assembly.—Referring now more particularly to Figs. 2 to 4, the base assembly, referred to generally at 11 in Fig. 1, comprises the base plate 12 formed of a sheet of flat plywood having a series of holes 13 through which securing means may be driven, such as spikes, one of which is shown separately at 14 in Fig. 2*a*. Upon the base plate 12 is a supporting clevis, yoke or the like 15, also desirably formed of flat or molded plywood and attached as by bolts or the like, the base plate being formed with receiving bosses therefor if desired. While within the invention this base plate and clevis may be formed otherwise than of plywood, as of metal or other material, the plywood construction is preferred in the interest of lightness. The spaced upright portions or arms of the clevis 15 are horizontally apertured in alignment to receive a clevis pin or pivotal bearing 16 which may be provided with a metal or other bushing and with end washers 17 together with means such as cotter pins 18 for removably securing it in place.

Pivotally associated with the base-plate clevis through the medium of the pin 16 is a bracket indicated generally at 20, Fig. 3. It comprises a lower or bearing portion 20*a* apertured for reception upon the pin 16 and providing a seat as at 20*b* for the mast cylinder element 19. This bracket 20 may be formed of flat or molded plywood or otherwise, but in any instance the mast cylinder or socket element 19 preferably is made from a section of the tubular plywood material such as described in connection with Figs. 5 and 6, for direct reception of and contact with the like-formed mast proper.

The bracket 20 further comprises a wing or lateral fin-like extension 20*c* having a bifurcated upper portion having bearing apertures for a pin 21 providing the pivot connection for the boom cylinder or socket 22. This latter likewise is of the tubular plywood structure such as that

of Figs. 5 and 6. Its pivoted inner or lower end has secured to it a longitudinally projecting flange 22*a* received in the upper bracket portion 20*c* and apertured for passage of the pivot pin 21, the latter provided with securing means as end washers and cotter pins, and if desired a bushing, in a generally similar manner as for the pivotal connection between the bracket 20 as a whole and the base clevis 15. A cross-member 23 fixed adjacent the pivoted end of the boom cylinder serves as a stop for the inserted end of the boom F. The tubular plywood mast cylinder 19 is firmly secured upon the lower or seat portion 20*b* of the bracket and against the adjacent inner portion of the lateral extension 20*c* thereof, the bracket being of a general L-shape in side elevation and affording both horizontal and vertical support for the mast cylinder in the upright or erected position of the mast in which the parts are illustrated in Figs. 2 to 4.

Appropriate means are provided for removably securing the mast and the boom in their respective cylinders 19 and 22 of the base assembly, one preferred form of such means being shown in Figs. 2 to 4. For this purpose the upper or outer portion of the tubular plywood walls of these cylinders are each provided with a relatively narrow longitudinal recess or slot formation, as at 19*b* and 22*b* respectively. These may be at any convenient point about the circumference of the respective cylinders and are of approximately one-half the longitudinal extent of the latter. Surrounding the slotted upper end of the mast cylinder is a yieldable clamp element 24 of metal or other material, the upper portion 20*c* of the bracket 20 being recessed as at 20*d* to receive it. This clamp as shown comprises a split ring or collar having at its adjacent ends radially projecting ears 24*a* apertured to receive an adjusting screw, wing bolt or the like 25 threaded into a nut 25*a*. The latter may be welded upon one of the ears, the threaded end of the bolt desirably being peened over to retain it upon the clamp. The slotted end of the tubular plywood cylinder 22 likewise is equipped with a resilient clamp ring 26 having similar nut and bolt tightening means 27.

Telescopic tubular plywood mast assembly.—Referring now more particularly to Figs. 7 to 10, to be considered in connection with Figs. 5 and 6 already described, I have in Fig. 7 diagrammatically illustrated a series of component tubular plywood elements A to E for a five-section mast, such as that of Fig. 1. Depending on the length and diameter of the individual sections the overall height or length of such mast may be selected within a wide range between lower and upper limits. For convenience in description, and merely by way of example, both Figs. 1 and 7, also Fig. 10 may be regarded as representing a 50-foot radio mast, selected as typical of the invention. It will be understood however that the mast of the present invention may comprise any plurality of sections up to nine or more, and may range in overall lengh from a few feet up to 110 feet or more. In other words, a five-section mast may be other than 50 feet in total length, and conversely a 50-foot or other length of mast may be made in other than five sections.

In the selected specific example of a five-section 50-foot mast the first and largest section A, for the lowermost position, may appropriately have an outside diameter of 6 in. and a length of 10 ft., 6 in. The following sections such as

B to E graduate downward in outside diameter, as for example 5½, 5, 4½ and 4 in., likewise with overall lengths of 10 ft., 6 in. for B to D sections and 11 ft., 9 in. for the top section E. The decreasing scale of outside diameter (O. D.) is continued as to the boom F which is approximately 3⅜ to 3½ in. O. D. and is illustrated as a single-section element, an appropriate length for which in the assumed example is not more than 11 ft., 9 in. The decreasing diametral scale is further continued as to the cross-arm G, if such element is included. Such cross-arm G accordingly may be of 2½ to 2⅝ in. O. D., with a length of about 8 ft. more or less.

The relative lengths and diameters of the tubular plywood sections or elements A to G are by the invention calculated with particular view to the desired nesting or telescoping of the entire mast assembly into a package of minimum bulk, such as illustrated in Fig. 10. The exemplary section lengths given above are overall. That is, as to the intermediate and top mast sections B to E they include the joint-forming or relatively short inserting portions and also the relatively longer exposed portions, the latter in turn including, in the illustrated example, the external abutment or positioning collars **40** to be described. Such inserting portion for the sections B, C and D, in the example under consideration, may be 12 in. and for the top section E, 9 in., said collars having a length of 3 in. or thereabouts. This results in the assembled position of Figs. 1 and 7 in the selected total 50-foot length for the mast, made up of the 10 ft., 6 in. extent of section A, the exposed extents of 9 ft., 6 in. each (including their collars) for sections B, C and D and an exposed extent of 11 ft. for the top section E (including its collar).

To give but one other dimensional example the several hollow tubular elements for a 90-foot mast assembly elected to comprise nine sections for the mast proper (the number may be other than nine) the O. D. values may be 7½, 7, 6½, 6, 5½, 5, 4½, 4 and 3½ in. respectively, with individual lengths of 10 ft., 9 in. (overall) and 12 in. inserting or joint portions, the final or topmost section being somewhat longer if desired. A two-section boom of about 20 ft., 6 in. assembled length may then be provided in such instance, one section of 10 ft., 9 in. and the other of 9 ft., 9 in. plus a 12 in. inserting or joint portion. The cross-arm if any may be any desired proportionate length, as 9 to 11 ft., such plural-section boom and cross-arm being diametrally proportioned for nesting with the mast sections or for mutual nesting separately therefrom. In any instance it will be understood that the wall thickness of the sections is not greater than, and for tolerance purposes preferably somewhat less than, the O. D. difference between successive sections.

By way of emphasis, it is again noted that the invention, while comprising the relative proportioning, arrangement and structural interrelation of the several tubular elements is in nowise limited to specific dimensions of parts, such considerations as length, outer and inner diameter, wall thickness and others being determined in accordance with the circumstances and demands pertinent to the particular installation and attendant use conditions.

Among the important features of my present invention, both as regards the mechanical structure and the method of fabrication and assembly, are the abutment or positioning elements, rings or collars **40** briefly mentioned above, for accurately relatively locating and supporting the assembled mast sections. One such element **40** is incorporated with each mast section excepting the largest or lowermost section such as A. These tubular or cylindrical elements **40**, similarly as the tubular mast sections themselves, preferably are constructed of wound wood veneer or plywood in the manner as explained in connection with Figs. 5 and 6, but within the invention may be otherwise formed. Further, it is of substantial importance that such positioning or abutment element for any given section shall conform dimensionally with the section to be engaged by it and that its abutting end wall shall have a firm and direct seat against the corresponding end wall of such engaged section.

Noting particularly Figs. 8 and 9, each such abutment element comprises a ring, sleeve or collar **40** preferably, as stated, of multiple-ply wound tubular veneer or plywood formation described. Since such element **40** for each section so equipped is or may be similar except as to diameter, the reference numeral **40** is applied generally in Fig. 7 on each of sections B to E. Figs. 8 and 9, illustrating the preferred construction in more detail, may be regarded as representative of any of such sections B to E. Further, these butt-joint defining elements **40** may within the invention be disposed either internally or externally of the respective sections. When internally disposed they may be located adjacent the upper or outer ends of successive elements beginning with the lowermost or largest, such as A, thus requiring none for the last or top section such as E, or they may then be in the preferred relative positions as indicated in Fig. 7 for their external locations. As the fabricating method and means of securing these abutment rings, collars or the like **40** may be substantially the same whether inside or outside the tubular plywood mast sections, it is sufficient to illustrate them as external, which construction is preferred as generally facilitating the manufacture, inspection and use of the parts concerned.

As one feature of the structure and method of the invention, these abutment elements, rings or collars **40** are preferably not only of the multiple-ply wound tubular veneer or plywood construction of Figs. 5 and 6, but also are directly cut or otherwise taken from a portion of the same or a similar tubular plywood element which is to be employed in the formation of the mast section of next larger diameter (or smaller diameter in the internal form) than that to which the particular ring or collar **40** is to be secured. Desirably such collar piece is so utilized that in the assembly of a given mast it will abut endwise against the plywood tubing portion from which it was cut off, and in substantially the same circumferential relation, thus insuring accurate counter-fitting abutment between the subsequently assembled sections. It is to be understood, however, that within the invention the collar elements **40** may be made separately or otherwise than as above described; but for speed and convenience they are fashioned from a wound tubular plywood section of the appropriate diameter.

It is of the utmost importance that these rings, sleeves or collars **40** be secured firmly and accurately on the tubular plywood sections to which they pertain. Noting particularly Fig. 9, for that purpose I desirably first apply a layer or coating

of an adhesive or bonding agent 41, such for example as in the tubing structure of Figs. 5 and 6, to the appropriate surface area of the particular plywood tubing section. I overlay the adhesive with one or more turns of thin wood veneer as indicated at 42, as a filler and seating means, to a total thickness substantially equal to the diametral tolerance factor as between the section to which the collar is being secured and that with which said section is to be interfitted. Another layer or coating of adhesive desirably then is applied as at 43. Then I place the ring, sleeve or collar 40 itself concentrically in position in transverse line with said means 41 to 43, its accurate axial parallelism with the tubing axis being assured by said means, and also the true perpendicular relation of its end walls or edges relative to said axis. One or more screws 44 or equivalent mechanical connector means are then passed through the collar and into the substance of the tubular plywood section itself. Desirably as stated I combine the securing means 41 to 44, but in some cases any one of them might be omitted. However, it is considered important to employ at least two of these elements or means, namely the adhesive or bonding agent, the veneer winding and the mechanical connector, and preferably all three.

In order readily to nest or telescope the tubular plywood elements of the mast assembly into a unitary package for shipping, as illustrated for example in Fig. 10, a substantial tolerance is provided as between the outside diameter of a given section and the inside diameter of the one next larger and into which the first is to be telescoped. At the same time it is of extreme importance that the inserting portions of the respective mast sections, that is, their portions between the abutment collar 40 and the nearer end of the given section, shall have a firm, tight fit into the cooperating section, in the assembled position of the mast as in Fig. 1. Such tight interfitting however must be consistent with the desired capacity for rapid dismantling and repacking of the mast.

Accordingly, and referring now particularly to Fig. 8, I apply about the inserting portion of the typical mast section such as D to E there illustrated, one or more turns or winds, preferably straight-on or convolute, of thin wood veneer 45. This may have a gauge of the order of 1/64 in. more or less, and is applied to a total thickness approximating or somewhat less than the described dimensional tolerance between the several engaging sections. Such additional veneer layer or layers are bonded into position, desirably similarly as in connection with Figs. 5 and 6. They are then worked down as by sanding or other shaping and finishing operation to afford them a definite but scarcely noticeable longitudinal taper, as at 146, Fig. 8. Said tighter layer 45 and the associated taper formation 46 desirably are extended along a major length of the inserting portion, substantially as represented in Fig. 8, from the abutment collar 40 to or approaching the adjacent end of the given section. It will be understood that in a construction wherein the abutment elements or collars 40 are internally located, this tightener or taper element 45—46 is correspondingly internally applied.

By reference now more specially to Fig. 10, illustrating a nested, telescoped or packaged condition of the elongated tubular elements of a five-part mast assembly, together with the boom F and cross-arm G as comprised in the typical equipment of Figs. 1 and 7, it will be observed that the sections A to E are disposed one within the other, but in a reverse endwise relation from that of their use assemblage as in Figs. 1 and 7. In other words, the second or next lowest mast section B is slid or inserted into the section A of largest diameter, with that end first which is distal from its abutment collar 40. That is, the relatively longer portion of the given intermediate section (B), that which is exposed in the erected Fig. 1 position, is received within the next larger section (A), up to the collar 40 of the received section. The relatively shorter or inserting portion of the received section, that at the left in Fig. 8, and which here externally carries the described taper fitting formation 45—46, accordingly is not directly engaged circumferentially by any enclosing part. In this manner the tight-fitting feature for the inserting portions of the several mast sections is coordinated with the feature of their telescopic nesting and packaging for transport.

It will further be noted in this connection that the relative lengths of the several tubular plywood elements of the entire assembly are so calculated as to afford the desired compact minimum-length package, such as that of Fig. 10. The latter represents a five-piece mast structure together with the appropriate boom F and a cross-arm G, as assumed in the typical embodiments of Figs. 1 and 7, already described by way of one specific dimensional example as a 50-foot installation. Again referring to the stated exemplary dimensions for a mast of said 50-foot height, it will be seen that the overall length of the package is but 11 ft., 9 in., as determined by the longest of the several sections, in this instance the top mast section E, seen in the fifth from outermost position in Fig. 10.

For the assumed 50-foot mast an appropriate length for the erecting boom F likewise is 11 ft., 9 in. As previously stated, it is diametrally proportioned with reference to the top mast section E. Accordingly it is adapted both diametrally and longitudinally for telescoping as a single-section unit within such mast section (E), and is so shown in Fig. 10.

A single-section cross-arm such as G up to a length of as much as 11 ft., 9 in. may be provided consistently with the formation of the desired minimum-length telescoped package such as that of Fig. 10. Such cross-arm G, when employed, desirably is diametrally graduated in the similar descending scale, as previously stated, thus adapting it for reception within the boom F, where it is shown in Fig. 10. Since an appropriate cross-arm length for the 50-foot mast assembly of the assumed example is but 8 ft. or thereabouts, such cross-arm element G as represented in Fig. 10 is substantially shorter than the boom section F in which it is received.

Further in connection with the package of Fig. 10, and considering still the assumed example of a 50-foot mast made in five sections with the illustrative dimensions as already listed, it will be noted that the overall length of any two successive nested intermediate sections such as B and C likewise totals 11 ft., 9 in. That length is comprised by the two mutually nesting longer portions of such sections, occupying a length of but 9 ft., 3 in. (9 ft. 6 in. less the 3 in. extent of their collars 40) plus the combined 6-in. length of their respective collars, plus the combined 2-ft. length of their respective shorter or inserting

portions, each of a 12-in. length. Said collars and inserting portions respectively for any two successive nested sections lie at the opposite ends of the package such as that of Fig. 10. It will be noted in that figure as to the fifth and in this instance top mast section E, having a somewhat shorter inserting portion (9 in.), that its abutment collar **40** is longitudinally spaced from the adjacent end of the next larger section (D) and out of transverse line with the collar of the second-larger section (C). Thus within the invention, and with reference both to the structure and assembling of the mast and to the telescopic packaging of the tubular elements, a substantial opportunity for dimensional modification is afforded.

In order to hold the several tubular plywood members or sections in their nested or package position of Fig. 10, I provide packaging means herein consisting of shipping caps **47**, **48** for the respective ends of the telescoped sections. Each consists of a cylindrical or laterally enclosing part **47***a*, **48***a* respectively, those desirably of the wound multi-ply wood, veneer or plywood structure of Figs. 5 and 6, and having secured at their respective outer ends transverse strips, cross-members or heads **47***b*, **48***b*, preferably of a flat plywood formation. Such shipping caps are of like diameter, to fit snugly over the outermost of the nested sections, here section A. They have a length or depth adequate for substantial lapped engagement over and directly with the opposite ends of one and the same tubular section (A). While the length of the cap pair may be the same for each, the cap **48** at the right of the package of Fig. 10 is shown as somewhat shorter, for saving in weight and material, as permitted by the proximity of the outer section (A) at that end of the package. These caps **47**, **48** together with the nested mast, boom and cross-arm sections or elements generally constitute the desired compact minimum-length package for transport. In mast types not having cross-arms, the latter is omitted from the package, while in any of the masts of extreme height, such as in excess of 70 to 80 ft. or thereabouts and which may require a plural-section boom, such boom sections are themselves proportioned for telescoping reception in the package unit, or they may form a separate package, together with the cross-arm if any.

It will be evident from the foregoing description that my invention includes that method of making a telescopic tubular plywood radio or like mast which involves first the step of constructing a series of multiple-ply tubular wound veneer or plywood sections of successively lesser diameter and each incorporating both spirally wound veneer layers or plies and also an intermediate straight-on or convolute wound length-grained multi-ply veneer stratum all unitarily bonded together; severing from such or similar tubular plywood sections a corresponding series of rings or collars; securing said rings or collars respectively to the outer surface of that tubular plywood mast section of next smaller or larger diameter than that from which the respective ring or collar is made; and assembling the mast sections by inserting into one end of each such a corresponding end of the next smaller section so as to abut the ring or collar of one with an end wall of the next.

It will be ncted that in this manner the multiple-ply tubular veneer material of each ring or collar is in assembling the mast brought into an edge-to-edge relation with an end edge of the next section, and around the full circumference of the engaged parts, thus providing an accurately abutted joint structure, wherein like materials are mutually interengaged. Hence an end wall of one mast section and the opposed end wall or edge of the adjoined ring or collar of the next directly engage each other in a symmetrical arrangement or continuation one of the other, so as most effectively to support the weight of the sections thereabove. Each ring or collar acts as a limiting or positioning device for each adjoining pair of tubular plywood sections. That is, in the external form illustrated, each collar abuts directly against the upper edge of the section next below it, preventing further relative endwise movement between them and directly transferring the weight of those above to those below. In such case the lowermost and as herein illustrated the largest of the sections, bearing the greatest weight, has no collar and is engaged directly upon its upper end wall or edge.

If the rings or collars are positioned internally instead of externally, it will be understood that each mast section except the topmost, but then including the lowest section, has such a ring or collar secured therein, whether the several sections are of graduated diameter or otherwise. In the preferred construction the mast sections are of successively smaller diameter, as herein shown, the abutment means or collars **40** are external and the largest mast section (that is, the lowest when the mast is assembled) omits such ring or collar.

The cross-arm assembly.—This element of the mast equipment will be understood as optional. Installations which do not require a cross-arm have substituted therein a mast top-stay collar such as subsequently described in more detail herein with reference to the mast-erecting boom and by reference to Figs. 14 and 15. When employed, the cross-arm assembly includes a support or fitting unit shown particularly in Figs. 11, 12 and 13 and there indicated generally by the numeral **50**. It may be of metal or of other construction, such as the wound multi-ply veneer tubing formation of Figs. 5 and 6, in which case the stay-attaching eyes and the securing means to be referred to are attached as by screws, rivets or the like, or by welding or other attachment to securing members or strips as in Fig. 18 to be described.

Said fitting or unit **50** mainly comprises two cylindrical members or tubes **51**, **52** disposed and rigidly interconnected with their axes mutually perpendicular, as best seen in Figs. 11 and 12, noting also Fig. 1. When of metal these tubes **51**, **52** are welded together or otherwise united into the T-like structure illustrated, and in other instances they may be appropriately bonded and strapped together in the angularly interfitted relation shown and in which the top member **52** seats in an arcuate channel-like formation provided at the upper end of member **51**. The lower or upright tube **51** of this unit, having reference to its use position, is adapted for seated reception on the free end of the final or top mast section, such as E of Figs. 1, 7 and 10. There is provided at its outer wall, as by welding, a number of rings, eyes or the like **53** corresponding in number to and similarly angularly spaced as the mast and boom anchor points, such as W, X, Y, Z, previously referred to in connection with Fig. 1. These eye formations **53** receive the stays, guy wires, ropes or chains leading to three of the anchor points as X, Y and Z and to the outer

end of the boom F, Fig. 1. At or near its upper end, this cap-like tube 51 is provided internally with limiting or seating means for engagement with the top or outer end wall of the last mast section (E). As illustrated such means comprises an inturned annular rib or flange 54, integrally or otherwise formed. Between such means 54 and the horizontal tube member 52, the member 51 may be tapered or flared, depending on the relative diameters of the two perpendicularly related tubular parts 51, 52, such taper formation being indicated at 55, Figs. 11 and 12, as appropriate for a cross-arm G of smaller diameter than the top mast section such as E.

The top or horizontal tubing member 52 (again with reference to the use position) forms the immediate receiver or holder for the cross-arm proper, such as the wound tubular plywood element G referred to at various previous points in connection with the consideration of Figs. 1 to 10. This tubular element G, generally constituted as a one-piece or single-section tubing unit is, in assembling the parts, inserted through said member 52 of the cross-arm support to the proper distance, usually so as to extend equally at opposite ends thereof, and is removably fixed in place. For this purpose the holder member 52 is provided with one or more apertures through its wall, the tube having welded or otherwise fixed at its outer surface opposite each such aperture a nut 56, one of which is indicated at the upper central location in Figs. 11 and 12, receiving a thumb screw, wing bolt or the like 57 for securing engagement with the installed cross-arm G. The mast-engaging or upright tubular member 51 of the support unit desirably also is equipped with securing means. As seen at the lower right in Figs. 12 and 13, such means comprises a welded nut 58 and associated wing bolt or thumb screw 59 similarly as for the cross-arm receiving tube 52.

The described support or fitting unit 50 of Figs. 11 to 13 thus conjointly incorporates in effect a top cap for the mast, a mounting means for the cross-arm and also a receiving collar or attaching means for stays or the like at the mast top. The unit as such presents a novel structure constituting a feature or sub-combinational element of the invention as a whole. As noted, for mast installations not requiring a cross-arm, a top stay collar is provided for the upper mast section. Such collar may consist of a tubular element substantially similar to the lower or upright tube 51 of the described support unit 50, up to and including the transverse fitting means or flange 54 thereof, being then generally similar to the boom stay collar now to be described, except as to one of the stay-attaching eyes.

The boom stay collar.—The erecting boom for the mast, such as the wound tubular plywood element F previously mentioned, and which may consist of a single section as illustrated or a plurality of interfitted sections similarly constructed and adapted for telescoping as the described mast sections such as A to E, has provided for its outer end a collar or like device for attaching reception of one end of certain of the mast stays, two of the anchor stays or chains, and one end of the block-and-tackle equipment, all as previously described in connection with Fig. 1. In mast assemblies up to and including those of 70 ft. or thereabouts such single-section boom may be employed.

Referring now more particularly to Figs. 14 and 15, illustrating a preferred construction for such boom stay collar, the latter as there shown and indicated as a whole by the numeral 60, comprises a ring, sleeve or the like 61 having welded or otherwise secured at the appropriate points about its outer wall a plurality of rings, eyes or the like. Three of these, as indicated at 62 project in planes radial of the collar proper 61. A fourth eye 63 of such plurality preferably is disposed at right angles to the others, in a plane transversely perpendicular to the collar axis. This latter eye 63 is thus better adapted for the attachment of the block-and-tackle of Fig. 1, while the other eyes 62 as disposed are appropriately presented to receive the corresponding mast and anchor stays or chains as already explained.

For properly locating and seating the boom stay unit 60 at the outer end of the boom such as F and positively to prevent its undesirably riding down upon the boom, it is provided with means such as the inturned flange, annular rib or the like 64, adapted for seating engagement against the outer end edge or wall of the boom. As in the instance of the member 51 of the cross-arm support of Figs. 11 to 13 such locating and limiting means 64, which need not be circumferentially continuous, may be integrally or otherwise formed, as by inturning one edge portion of the wall member 61. Such flange or like means 64 desirably conforms in width to the wall-thickness of the tubular section with which it engages, particularly when the particular end collar is to be employed at the top of a mast not having a cross-arm as above referred to. An opening giving access to the hollow interior of the mast is thus afforded as may be desired for the installation of electrical conductors, wires or other means. A welded or otherwise affixed nut 65 and associated thumb screw or wing bolt 66 desirably is provided for removably securing the boom stay collar in place, similarly as in connection with the cross-arm support 50.

Intermediate mast stay collar or collars.—With many installations, particularly the relatively shorter masts up to 40 feet or thereabouts, no staying generally is required other than at the mast top. In other instances one or more sets of intermediate stays are desirable and for the purpose of the present disclosure I have assumed such to be the case as to the five-section mast illustrated, whether the same be of the assumed 50-foot length or otherwise. One such stay attaching means is illustrated by way of example in Figs. 16 and 17, the unit being therein generally indicated by the numeral 70. In the typical assembly of the five-section mast such stay unit or collar may appropriately be disposed just above the third mast section, such as section C of Figs. 1, 7 and 10, being so indicated in Fig. 1. In for example seven to nine section masts, stay collars generally are located just above the fifth section and the seventh section.

Each such collar consists of a metal or other ring 71 of the proper diameter for reception at the desired point of the given mast installation. This ring has welded in radially projecting position about its outer surface a number of stay-attaching eyes or the like 72, four being represented in this instance, equally angularly spaced. In this connection, and also with reference to the stay-attaching means of Figs. 11 to 13 and Figs. 14 to 15, the eyes or like members may be other than four in number and otherwise spaced than as herein represented. The illustrated num-

ber of four, however, is preferred as most convenient and efficient for the purposes.

In Fig. 18 I have illustrated an alternative form of clamping or securing means such as may be employed in association with any of the hollow cylindrical multi-ply wound veneer or plywood elements within which a received member is to be releasably fixed. Such elements may include for example the mast cylinder 19 of the base assembly, the boom cylinder 22 thereof and one or both tubes 51, 52 of the cross-arm support. With reference to said mast and boom cylinders 19 and 22 the means of Fig. 18 represents one alternative structure in place of the clamp-ring and slotted cylinder formation described in connection with Figs. 2 to 4. The multi-ply wound veneer or plywood tubing S of Fig. 18 accordingly may be regarded as representing a section of any of the cylinders or tubes above mentioned. A short steel or other metal strip 80 arcuately shaped at its inner face to conform to the tubing surface is secured to such tubing S as by wood screws, rivets or the like 81. At an aperture in the strip, and which is continued through the adjacent wall of the tubing S, there is fixed at the outer face of the strip 80, preferably by welding, a nut 82, for reception of a wing bolt, thumb screw or like threaded member to be set up against or into the inner element to be secured. Any desired plurality of such nuts and threaded members may be employed on a given strip, and a plurality of the latter may be variously located on any given tubular plywood section.

Having now described the readily portable mast assembly of the invention and the method of proportioned structure, arrangement and fabrication of its component elements, their packaging for shipment and their assembling and erection for use, it will be understood that the invention, while especially adapted to the field of radio masts, for which purpose it now includes among other users the armed forces of the United States, is applicable to numerous other uses, as for one example, in tent poles of various types and sizes, indeed for any work where telescoping tubular structures having the warmth, lightness and other beneficial characteristics of wood are advantageous. As explained, the overall or assembled length of my telescopic tubular plywood structure has a potential wide range. By way of further example, it may be as short as a 3-foot tent pole comprising 14 in. sections, or it may be a 90-foot or longer mast, having any convenient number of sections up to nine or more. It also will be apparent that the multiple-ply wound wood veneer or plywood formation as described in connection with Figs. 5 and 6 and by reference to my earlier applications identified largely contributes to the practical success of the invention, especially by reason of the incorporating of the longitudinally rigidifying layers, plies or strata thereof in which the grain of the wood is predominantly parallel to the axis of the tube sections.

While I am aware that telescoping tubular devices of metal are known, and that non-telescoping or nesting poles involving plywood have been suggested, I believe myself to be the first to provide a telescoping tubular mast embodying interfitting and nestable sections of wound multi-ply wood veneer having the advantageous features of great strength, lightness, compactness, warmth and the others as and for the purposes as herein disclosed.

Further by way of example in this connection, the required shipping space for a 50-foot mast embodying my invention, of the structure and arrangement as above described with reference to Figs. 1, 7, 10 and the others, is but 2.43 cubic feet, as contrasted with 9 cu. ft. or more for a sectional but non-telescoping or non-nesting wood mast of like height, and even greater cubage for a telescoping metal structure of said height, due to the bulky equipment required by reason of the great weight of such metal device which totals 400 lbs. or more as against but about 125 lbs. for a 50-foot mast assembly of my invention. Moreover, my mast, such as that of said example just noted, may be completely unpacked, assembled and erected by one person within about 30 minutes. Any at all comparable installation has heretofore required a crew of five men working three hours and in addition the use of a marine winch for the erecting of the metallic type of mast of a height of the order mentioned.

In the preferred embodiment all or substantially all of the parts and elements of my assembly are or may be of the tubular wound plywood structure disclosed, as to the cylindrical members, or of a flat or formed plywood as to non-cylindrical members, with the exceptions of the fittings, collars, bushings, pins and the like as noted. It will be evident from the foregoing, however, that metal may be employed for certain of the subsidiary parts other than those of said exceptions, such for instance as the base plate, the clevis or other parts of the base assembly. Also it will be understood that the split tubular formation and associated annular clamping means as illustrated and described in connection with the cylinders for the mast and the boom may also be utilized at other appropriate points as for the fixing of the boom stay collar, the mast top-stay collar for the non-cross-arm type and the cross-arm supporting means of the type so equipped.

Having thus described certain embodiments of the invention and the best mode known to me for practicing the methods thereof, it is to be understood that although specific terms are employed, they are used in a generic and descriptive sense and not for purposes of limitation, the scope of the invention being set forth in the following claims.

I claim:

1. That method of making portable tubular sectional telescoping radio masts which comprises fabricating lengths of cylindrical tubing of differing diameter by spirally winding and convolutely laying concentrically a multiplicity of plies of wood veneer to a given wall thickness and interbonding them into substantially homogeneous tubing structures, forming therefrom a series of cylindrical tubular mast sections of generally similar length and graduated in outside diameter by differentials slightly exceeding their respective wall thickness whereby to adapt them for endwise interfitted extended assembly and also for an endwise reverse telescopic packaging one in another, severing a relatively short annular portion from one end of each tubing length except the smallest thereof, wrapping and adhesively securing externally about the inserting end portion of each of the smaller tubing lengths wood veneer to a thickness substantially equalling the differential between its outside diameter and the inside diameter of the next larger tubing length, installing about such veneer wrapping at a location spaced lengthwise from the outer end thereof the annular portion severed from the

next larger tubing and there firmly securing it adhesively and mechanically and reducing the veneer wrapping circumferentially between the installed annular portion and the adjacent end of the tubing along a gradual and substantially uniform taper outward over a major extent of said distance defining the inserting portion of the given tubing length.

2. A portable mast for communications comprising, in combination, a series of elongated plywood tubing sections of mutually differing diameter adapting them for endwise insertive assembly into a hollow mast of given height, each smaller section having externally fixed adjacent its inserting end a concentric plywood tubing collar for direct endwise abuttive engagement with the end wall at the receiving end of the next larger section, said sections having a differential between the outer diameter of one and the inner diameter of the next larger adapting them for reverse telescoping in on another, said collars for the respective sections comprising relatively short lengths of the plywod tubing for the next larger section and each having concentrically disposed between it and its fixedly carrying section plywood filler and adhesive bonding means equalling in thickness said diametral differential.

3. In a portable sectional mast for communications, a plurality of elongated plywood tubing sections of approximately equal wall thickness, each of uniform diameter, the outer diameter of one being less than the inner diameter of the

next by a differential adapting them for overlapping endwise interfitting in assembled position and for endwise reverse nesting, and means carried by one section for positively limiting the extent of assembled overlapping interfit and for transmitting end thrust by direct engagement with the adjacent end wall of the next section in a transverse plane perpendicular to the longitudinal axis of the sections, said means comprising a plywod tubing ring concentrically disposed on the carrier section in predetermined spaced relation to the interfitting end thereof, of an outer and inner diameter conformant to the next section and having an outer end wall perpendicular to the section axes, a plywood layer interposed concentrically between the tubing ring and its carrier section and bonded at opposite circumferential faces to the ring and the carrier section respectively, said layer and bonding equal in thickness to the diametral differential between the sections, and mechanical means transversely interconnecting the plywood tubing ring, the plywood layer and the carrier section.

4. In a portable sectional mast according to claim 3, a construction wherein the plywood layer associated with the plywood ring is extended from the latter substantially to the adjacent end of the carrier section and is gradually tapered conically from a maximum thickness at the ring toward a zero thickness at said carrier section end.

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