

Aug. 22, 1961

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2,997,712

ANTENNA REFLECTOR CONSTRUCTION

Filed June 14, 1957

7 Sheets-Sheet 1

Fig. 2.

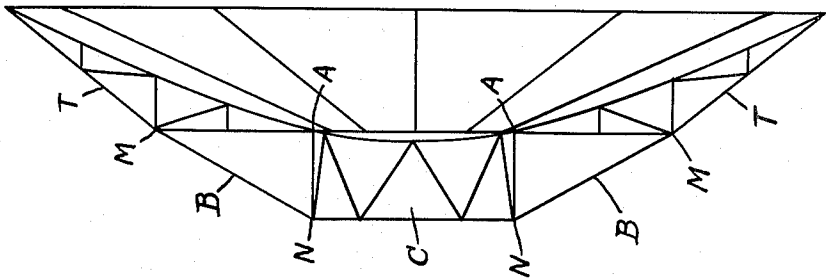
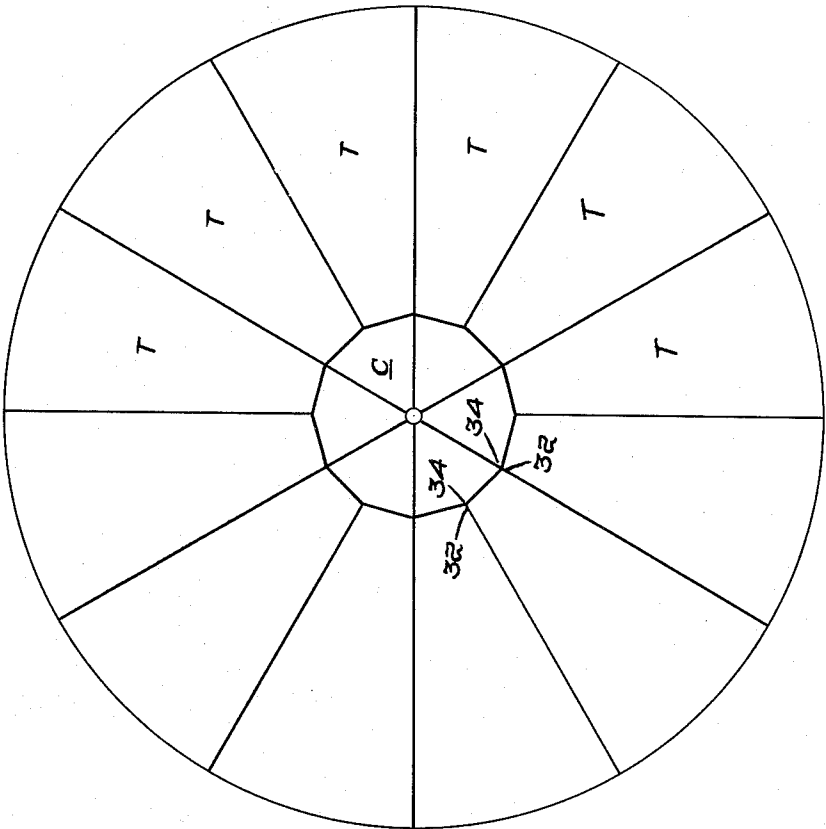


Fig. 1.



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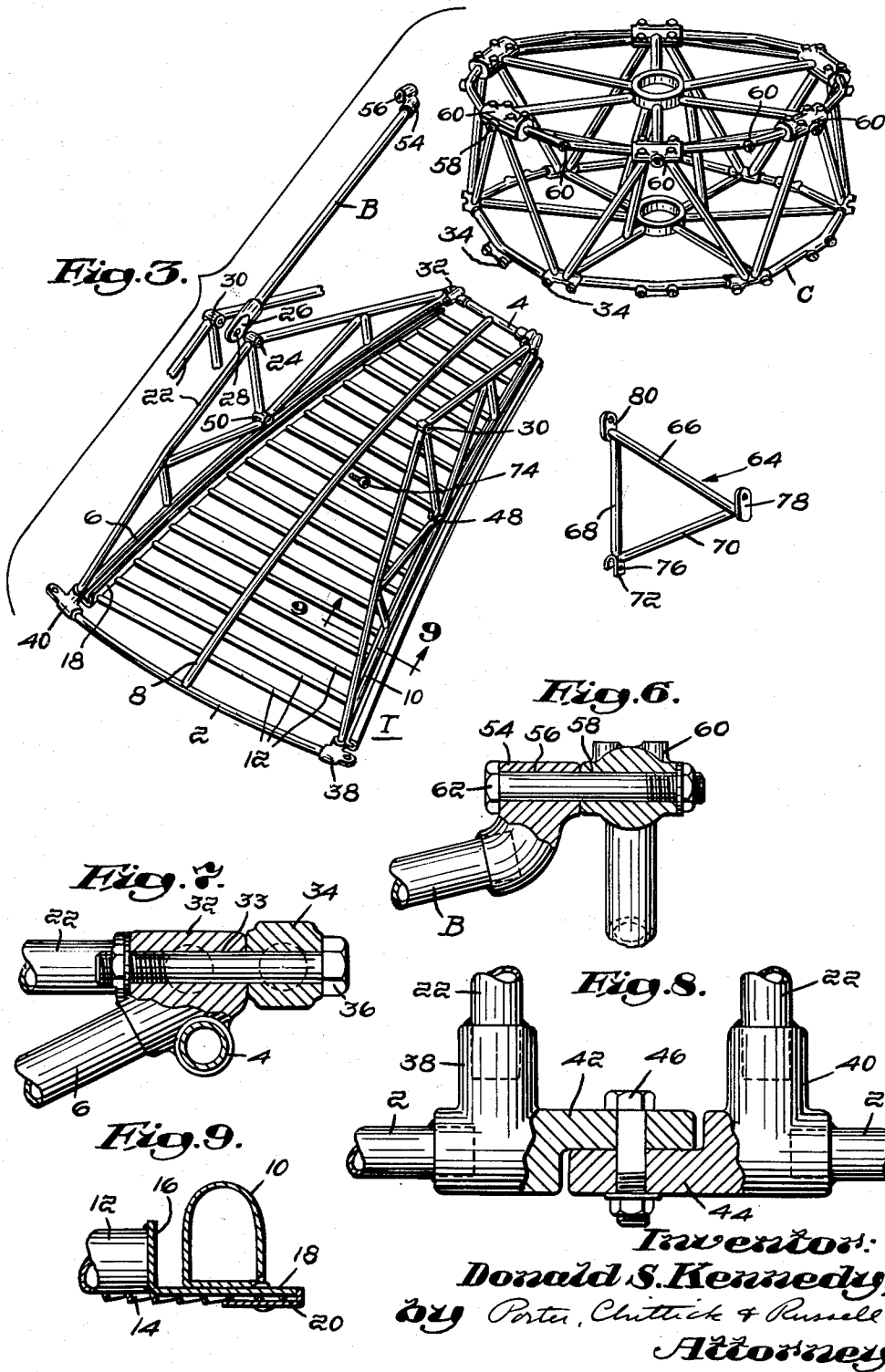
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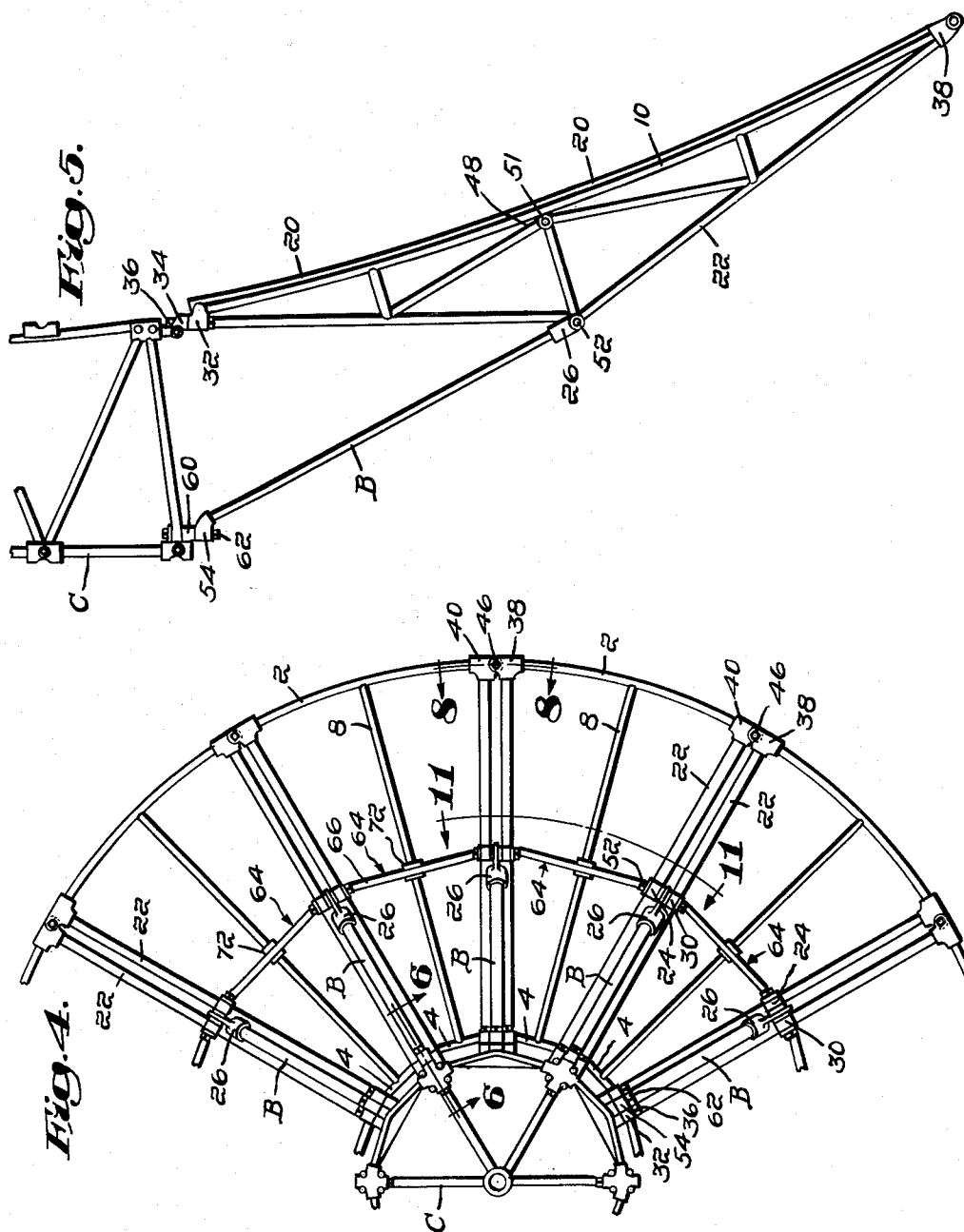
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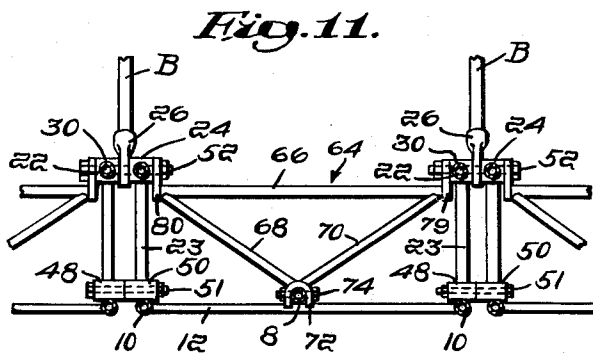
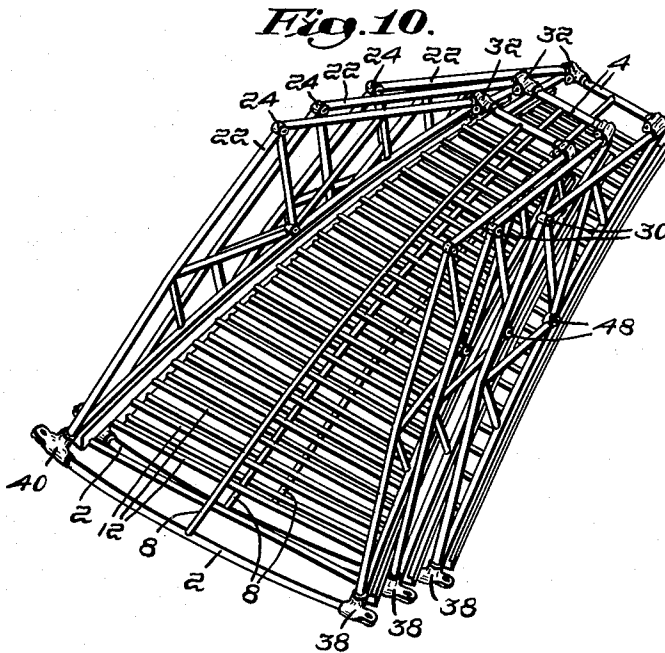
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Fig. 13.

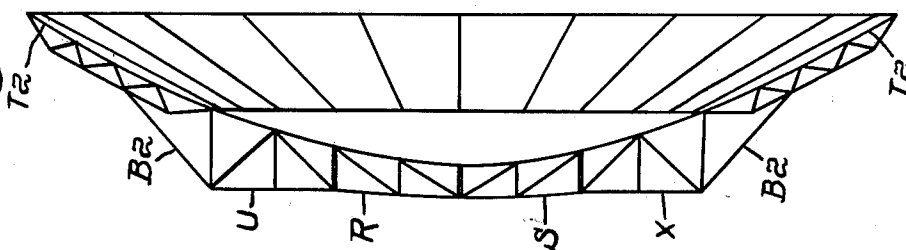
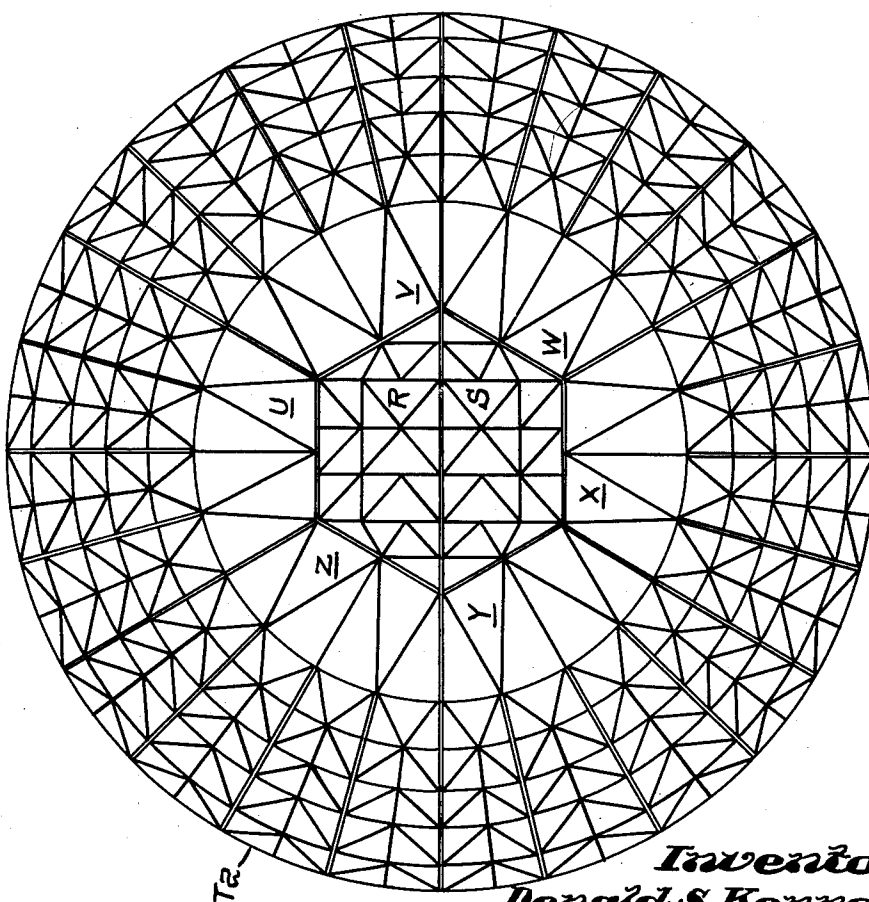


Fig. 12.



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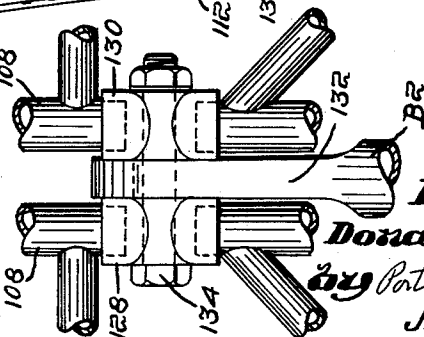
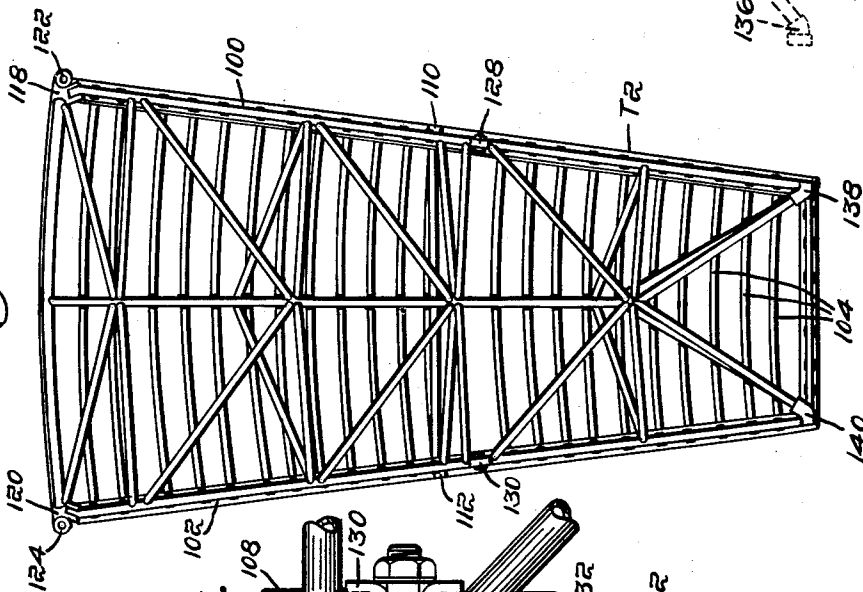
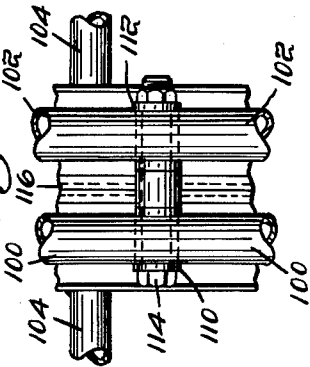
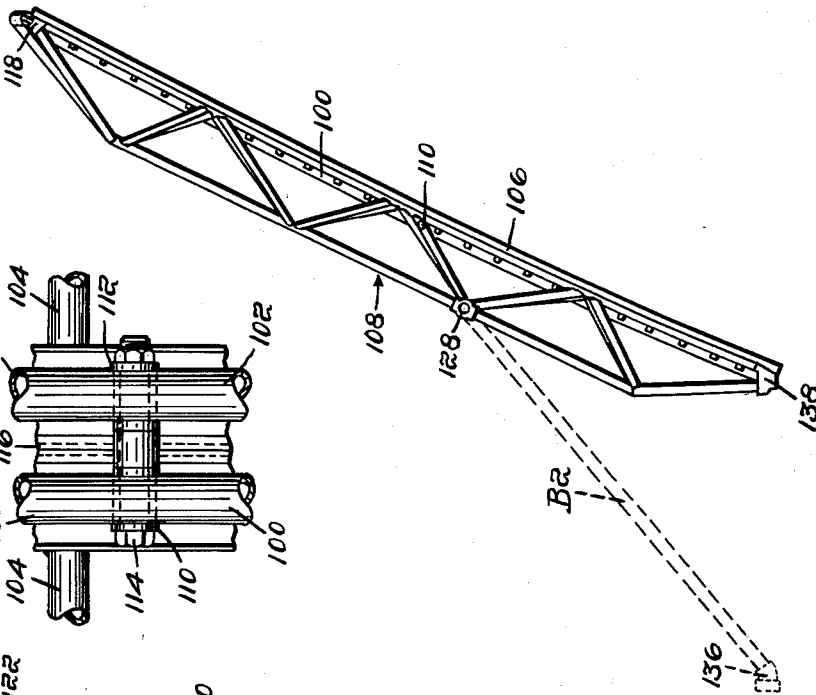
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Fig. 19.

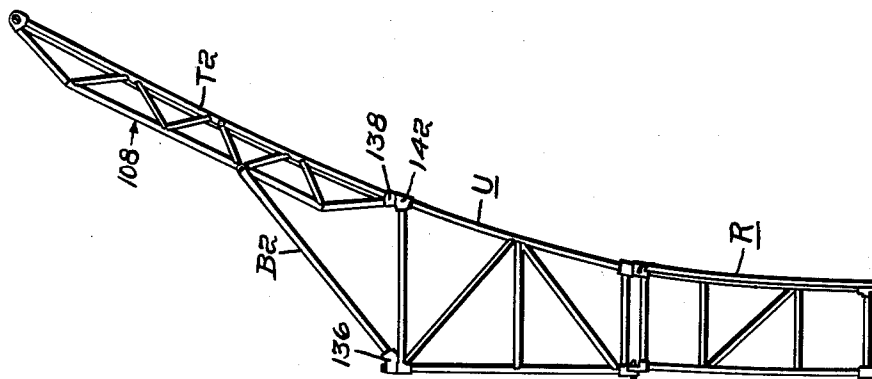
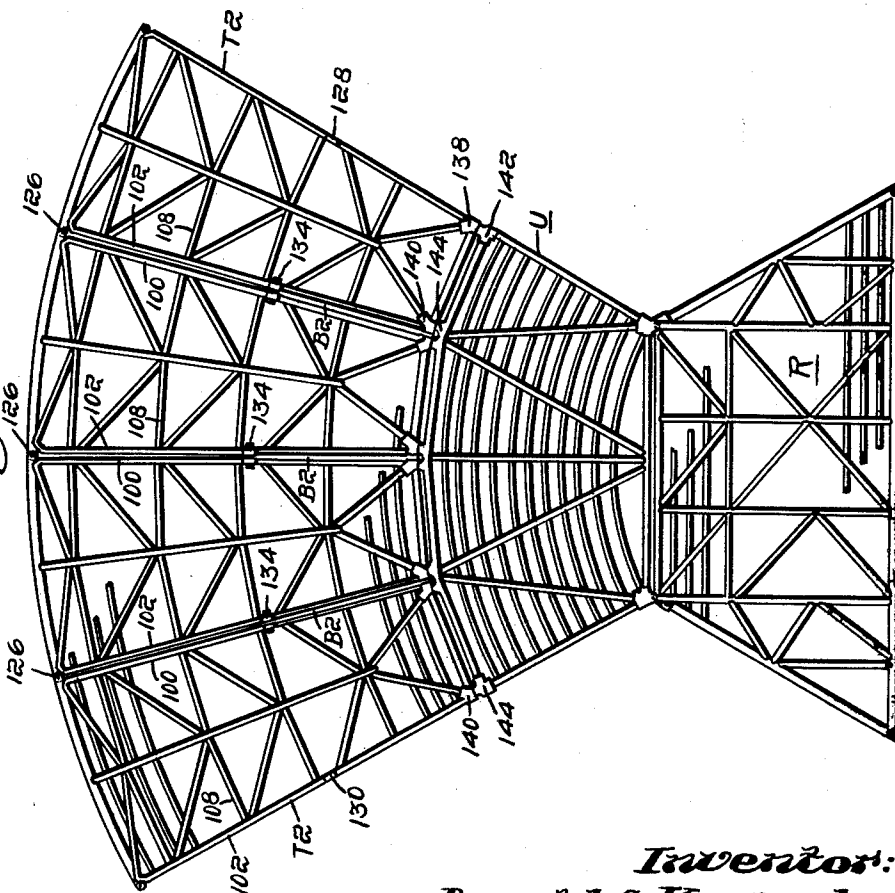


Fig. 18.



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ANTENNA REFLECTOR CONSTRUCTION

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9 Claims. (Cl. 343-916)

This invention relates to antennas and is particularly concerned with the large parabolic directional type that has come extensively into use in recent years.

As the art has progressed, manufacturers of microwave antennas have been called upon to make antennas of larger and larger dimensions. In theory this can be accomplished readily enough but in practice as the dimensions and weights of the antennas increase, constructional difficulties not present in the smaller sizes appear. Bracing must be heavier and deeper if the correct curvature is to be maintained. As the overall size of the antennas increase, there comes a point at which the factory made individual elements which comprise the final unit are so large that they cannot be shipped by conventional means. That is to say, the sections of which an antenna is made must be of such dimensions that they can be shipped by truck over the roads, on railroad cars and by boat.

A further problem with which the antenna manufacturer is confronted is the high cost of shipping, the cost being due more to the bulk of the parts than their weight. The parts are principally open braced structures of aluminum tubing rigidly welded and incapable of further disassembly. Such structural units as now made cannot be nested together and accordingly, each part occupies a large number of cubic feet in relation to its weight for which the carrier must charge. There have been occasions when the shipping costs of a large parabolic antenna from the United States to Europe have exceeded the manufacturer's selling price.

Since the national welfare will require the building of still larger antennas as the art progresses, it has been desirable to devise new structural arrangements which are capable of overcoming some of the foregoing enumerated disadvantages. The invention is primarily concerned with the provision of a new type of tip section construction and bracing therefor used in a parabolic antenna. Large size parabolic antennas are customarily made with a center section or core structure which may be made of a single welded unit or of a plurality of welded units of considerable depth. To the perimeter of the central section are affixed a plurality of tip sections which are generally in the form of truncated sectors all fitting together to form the outer annular portion of the antenna.

Since the tip sections or sectors are of substantial radial length (for example, in a 60 ft. diameter antenna the tip sections would be 15 ft. long and 7 to 8 ft. wide) they must of necessity be rigidly braced individually and so constructed that each section may be connected to the adjacent section and to the interior center core in a manner to produce a rigid whole when the assembly is complete.

Heretofore the manner of bracing the tip sections has resulted in a unit that could not be nested in any way with other similar tip sections. As a result high ship-

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ping costs for this particular portion of an antenna have always been present.

One of the objects of this invention therefore is to provide an antenna which includes as part thereof a plurality of tip sections of such construction that a plurality of such sections may be nested together in a relatively small space for shipping purposes. At the same time the construction includes special bracing at the rear of each section adapted to be connected by demountable struts to the rear of the interior core section. By this construction, economy of manufacture and economy of shipping is effected and the rigidity of the antenna upon assembly of the sections is maintained as successfully if not more so as in the case of the prior bulkier tip section forms.

The invention also includes a novel form of demountable brace which is removed during shipping but which may be installed at the time of assembly of the complete antenna to improve the rigidity of the tip sections.

The invention also includes a second or alternative type of tip section in which the rear bracing is of a shallow nature permitting the tip sections to be stacked one on top of the other to occupy a space only a fractional part of that occupied by the same number of tip sections of the prior art constructions. In this form the sections are not nested but economy of space in shipping is secured by the limited depth of the bracing. This form also permits the utilization of the same type of demountable braces or struts for securing the tip sections rigidly to the antenna core.

These and other objects of the invention will become more apparent as the description proceeds with the aid of the accompanying drawings in which

FIG. 1 is a front elevation of an antenna shown in schematic form in which there is a relatively small central section or core to which are directly secured a plurality of radially extending tip sections.

FIG. 2 is a vertical section of FIG. 1 showing the characteristic depth of the center section and the characteristic bracing of one form of the tip sections and the connection between the rear of the tip section bracing and the rear of the center section.

FIG. 3 is an exploded and detailed view of a one piece center section and one tip section of FIG. 1.

FIG. 4 is a rear view of four tip sections made in accord with the construction of FIG. 3, the tip sections being attached to the central section which is shown in part.

FIG. 5 is an enlarged radial section of the construction shown in FIG. 4, the tip section and strut being connected to the side of the central section.

FIG. 6 is an enlarged view partly in section and taken on the line 6-6 of FIG. 4, showing how the strut is connected to the rear of the central section.

FIG. 7 is an enlarged view also partly in section showing the means of connection between the inner end of the tip section of the center section.

FIG. 8 taken on the line 8-8 of FIG. 4 shows the manner in which each tip section is connected to the adjacent tip section at the outer periphery.

FIG. 9 is a section on the line 9-9 of FIG. 3 and shows the expanded metal facing secured to the tip section, the expanded metal not being included in FIG. 3,

FIG. 10 shows three sections of the type disclosed in FIG. 3 in nested position for shipping.

FIG. 11 is a section taken approximately on the line 11—11 of FIG. 4.

FIG. 12 is a front schematic elevational view of a larger type of antenna having a center section made of two units, six surrounding intermediate sections and 24 tip sections.

FIG. 13 is a vertical diametrical sectional elevation of FIG. 12.

FIG. 14 is a rear view of an alternative type of tip section, this being the type shown schematically in FIG. 12.

FIG. 15 is a side elevation of FIG. 14 showing the shallow type of tip section bracing used alternatively in place of the type shown in FIG. 3.

FIG. 16 is a detail showing how the supporting struts are connected to adjacent tip sections.

FIG. 17 is another detail showing the intermediate connection between the two tip sections.

FIG. 18 is an enlarged view of the upper central portion of FIG. 12 showing one of the two units forming the center section, one intermediate section and four tip sections. This view is from the rear and includes the struts that support the tip section.

FIG. 19 is a radial vertical section of FIG. 18.

In the detailed description which will now be made it will be understood that the invention is basically concerned with (1) a new and novel construction in which the tip sections are made in such manner that when nested or stacked they will occupy far less space than the tip sections of the prior art whereby they may be transported from the place of manufacture to the place of use more economically than heretofore and (2) a new and novel antenna construction including the center and tip sections and novel means for attaching the new tip sections to the center sections and to each other in a manner that will provide the necessary rigidity that is demanded of this type of antenna.

Generally speaking, in a parabolic antenna of the type disclosed herein the construction comprises a welded framework so designed as to present a parabolic face to which is applied a layer of expanded metal which reflects and concentrates at the focus the incoming signals. The structure of such antennas is necessarily made in sections so that the parts may be transported from the factory to the erection site for assembly at that point. The center sections to which the tip sections are affixed present no part of the present invention except insofar as the center sections cooperate with the tip sections in supporting the tip sections in their required positions. Accordingly, it is believed that it is unnecessary to provide a detailed description of the center sections (or the intermediate sections if there are intermediate sections) as these elements and the construction of the same are well known to persons skilled in this art. Furthermore, with respect to the details of welding and assembling the various structural members no extended explanation will be given because these procedures are also well understood. The intention is to disclose and claim the combination of a center section and tip sections in which the tip sections are braced at the rear in such manner that they may be either nested for shipping if of one type of construction or if of the shallow braced type may be piled in a relatively small space for shipping. Other details of the invention will appear hereinafter as the description continues in greater detail.

Referring to FIGS. 1 and 2 there is shown schematically a center section C to which are affixed 12 tip sections T. The number of tip sections, of course, can be varied and the periphery of the center section will be correspondingly modified in such case. FIG. 2 which is a vertical diametrical section through FIG. 1 shows schematically the center sections C which is of substantial depth (the distance from the front to rear) and appropri-

ately braced and the tip sections T which are of the nesting type shown in more detail in FIGS. 3 and 10. These tip sections are connected to the center section at their inner ends at the points marked A and are maintained in correct position by the struts B which extend from the intermediate points M of the bracing at the rear of the tip sections to the rear of the center section as at N.

Since all of the tip sections are identical and the center section to which the tip sections are affixed is of conventional construction, it is believed that it will be sufficient to describe a single tip section and its connection to the center section along with the means of connection to the two adjacent tip sections to present an explanation which will be sufficient to account for the entire structure.

Turning now to FIG. 3 there is shown from the rear an exploded perspective view of one tip section T adjacent the complete center section C along with a strut B which is removed when the tip sections are nested for shipping. Each tip section comprises a welded frame consisting of tubular end bars 2 and 4 connected by the radially extending tubular members 6, 8 and 10. Affixed to the radial members 6 and 10 in any suitable manner, one form of construction being illustrated in FIG. 9, are a plurality of transverse members 12 which serve as structural members and also act to support on the face thereof the expanded metal indicated at 14 in FIG. 9. Each end of each member 12 is secured to one face of an angle 16, the other face 18 being secured appropriately to bars 6 and 10. The edge of the expanded metal 14 is covered by an edge plate 20 to present a smooth radial edge which will abut against or lie close to a corresponding edge on the next tip section.

The radial members 6 and 10 are additionally braced by the triangular rear braces which are identical in all of the tip sections and which will be referred to as braces 22. Each brace 22 has intermediate its rear side a suitable element 24 adapted to make proper connection with the fitting 26 of brace B. In the form shown, element 24 is a bushing welded in the brace structure and is adapted to receive a bolt 52 (see FIG. 11) which will pass transversely through the bushing, through the hole 28 in the end of the fitting 26 and through a second similar bushing 30 which is part of the brace 22 of the next tip section.

In order that the tip sections may be properly connected to the next adjacent tip section and also to the periphery of the center section, the following construction has been found satisfactory. Each brace 22 terminates at its inner end in a fitting 32 having a radial hole 33 extending therethrough. The fittings 32 are spaced circumferentially a distance equal to the distance between the corresponding fittings 34 on the center section C. In the drawing in FIG. 3 it will be seen that the center section has been drawn to a scale somewhat smaller than that of the tip section T so that the distances in the drawing between fittings 32 and fittings 34 are not the same. However, it will be understood that the left pair of fittings 32 and 34 are in alignment and are bolted together by a bolt 36 and the right pair of fittings 32 and 34 will also be in alignment and similarly bolted together. Reference to FIG. 1 in which the location of fittings 32 and 34 are indicated and reference to FIG. 5 in which the connection is shown in side elevation will assist in the explanation. In FIG. 5 the bolt 36 that passes through fittings 34 and 32 is shown.

The outer edges of the tip sections are connected together by means of the specially designed fittings 38 and 40. (See FIGS. 3 and 8.) These fittings have sockets designed to receive the tubular frame members 2, 10 and 22 which are rigidly maintained therein by welding or otherwise. Fitting 38 has a laterally extending flange 42, which is adapted to overlie a cooperating flange 44 of the fitting 40 of the next adjacent tip section. Flanges 42 and 44 have holes therethrough which may be aligned to receive a bolt 46 which when secured holds the outer

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rim of each tip section securely to the adjacent tip section.

Intermediate the ends of radial members 6 and 10 are bushings 48 and 50 which lie in alignment with corresponding bushings in the next adjacent tip sections. (See FIGS. 3 and 11.) A bolt 51 may be passed through these abutting bushings of adjacent sections so that the sections may be securely fastened together at points intermediate their length as well as at their outer ends.

From the description thus far it will be seen that each tip section may be secured to the center section and to each adjacent tip section. Because of the parabolic character of the complete structure, it is obvious that when all tip sections are in position they will be capable of maintaining themselves in a self-sustaining relation with respect to the center section. However, due to the great loads that are applied to radar antennas by wind, rain, snow and ice, additional bracing is necessary and this is supplied in the form of a plurality of struts B which run from intermediate points at the rear of the trusses 22 to the backside of the center section C. This arrangement can best be seen by reference to FIGS. 3, 4, 5 and 11. As previously explained, each fitting 26 of strut B is fastened to a pair of adjacent trusses by a bolt 52 which passes through aligned bushings 24 and 30 at the rear of adjacent tip sections. The inner end of strut B terminates in a fitting 54 which has a radial hole 56 therethrough which may be brought into alignment with a corresponding hole 58 in a fitting 60 on the rear periphery of center section C. As shown in FIGS. 4 and 5 a bolt 60 may be passed through fittings 56 and 58 to secure the inner end of brace B to the rear of center section C.

In order to provide additionally against circumferential distortion an intermediate brace 64 (see FIGS. 3, 4 and 11) is provided which is located between bushings 24 and 30 and is held in place by the bolts 52 which also secure the outer ends of struts B. In order to facilitate connection of brace 64 to the bushings 24 and 30 the ends of member 66 have welded thereto vertical ears 78 and 80 with holes therethrough whereby they may be readily secured in the manner shown in FIG. 11.

Brace 64, shown in perspective in FIG. 3 and in elevation in FIG. 11, consists of a triangular structure with one member 66 parallel to members 12 and diagonal members 68 and 70 which meet at an inverted U-shaped element 72 which fits over member 8 and is secured thereto by a bolt 74 passing through aligned holes 76. Brace 64 is removed from the tip section when the tip sections are nested for shipping purposes as shown in FIG. 10.

From the foregoing explanation it is believed clear that the selected number of tip sections may be connected to the center section with all tip sections abutting each other and bolted together at their outer ends through the medium of fittings 38 and 40 and intermediate their ends by the bolting together of bushings 48 and 50 and located just back of the face of bushings 24 and 30 located in the rearwardly extending trusses. All tip sections are additionally supported to prevent movement in an axial direction by means of the struts B, each strut being connected at its outer end between the bushings 24 and 30 of the trusses 22 and at its inward end to the fittings 60 of which there is one for each strut located about the rear periphery of the center section C.

Another form of the invention is shown in FIGS. 12 to 19 inclusive. In this construction the center section is much larger and illustrates a type of antenna currently in use in which the diameter may be 60 feet or more. This form has two center sections R and S which when bolted together form a rigid framework with an hexagonal periphery. To each of the six sides of the hexagonal center are affixed 6 intermediate sections U, V, W, X, Y and Z. Each intermediate section has an inner face which parallels one of the hexagonal sides of the center section, two radial faces and an outer face which is a

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segment of a circle. It will be understood that when reference is made to the faces of the center and intermediate sections such faces are not in the form of surfaces as these sections are merely open frameworks made of tubular elements welded together as can be seen in FIGS. 18 and 19. The inner faces or parabolic areas of the center and intermediate portions are covered with expanded metal in the usual manner so as to form a reflecting surface and this reflecting surface is carried outwardly to complete the circular area of the antenna by affixing to the outer periphery of the intermediate sections 24 tip sections also covered with expanded metal, each tip section being designated T2 to distinguish these sections from the tip to sections T shown in FIGS. 1 to 11.

The details of the tip sections T2 are shown in FIGS. 14 to 19 inclusive and by reference thereto it can be seen that the tip sections are in general the same as tip sections T except for the details of the bracing or trusses on the rear side. In fact, it should be understood that tip sections T of FIGS. 1 to 11 could be used in the antenna shown in FIGS. 12 to 19 in place of the construction of tip sections T2. That is to say, the improvement common to both types of tip sections is that construction which permits each tip section to be secured at its inner end to the exterior of the center or intermediate section and including bracing in the form of a strut on the rear thereof that renders each tip section rigid in itself and with respect to the center section. This rigidity is supplemented by the affixing of each tip section to the adjacent tip section and by further bracing each tip section with respect to the center or intermediate section to which it is connected by a rearwardly extending brace designated B2 and shown most plainly in FIGS. 13, 15, 18 and 19.

It will be appreciated upon examination of FIGS. 14, 15 and 19 that the truss on the rear of each tip section is very shallow but still adequate to provide the necessary rigidity. The shallowness of the bracing enables the tip sections T2 to be stacked one upon the other without taking up much more room than the same number of tip sections made according to the construction of FIG. 3 when nested together as shown in FIG. 10.

Each of the tip sections T2 comprises two radially extending bars 100 and 102 to which are secured a plurality of circumferentially extending members 104. On the face provided by these members is positioned a layer of expanded metal indicated at 106 in FIG. 15 which may be fastened in the manner shown in FIG. 9 by spot welding or clips or otherwise as convenient.

At the rear of each tip section is bracing generally indicated at 108 consisting of a plurality of tubular elements arranged at proper angles to withstand stresses that may be applied to the tip section. These tubes are all welded together to form a rigid whole. It is believed unnecessary to describe the bracing system in detail as such procedures and constructions are well understood.

At a point intermediate the ends of members 100 and 102 and just behind the face are bushings 110 and 112. When two tip sections T2 are adjacent each other in the position they assume when connected to the intermediate sections R and S, the bushings 110 and 112 will lie adjacent each other as indicated in FIG. 17. This arrangement permits the adjacent tip sections to be connected together by a bolt 114 utilizing a tubular spacer 116 if desired.

At the outer corners of each tip section T2 are fittings 118 and 120 which are similar to fittings 38 and 40 shown in FIGS. 3 and 8. The ears 122 and 124 overlie cooperating ears on the adjacent tip sections permitting adjacent tip sections to be connected at their outer ends by means of bolts indicated at 126 in FIG. 18.

At intermediate points along the longitudinal sides of the trusses 108 are bushings 128 and 130 shown in FIGS. 14 and 15 and in enlarged detail in FIG. 16. These bushings in adjacent tip sections will lie along side of

each other but are spaced enough to receive therebetween the end 132 of strut B2. End 132 has a hole there-through so that a bolt 134 may secure the rear of the trusses of two adjacent tip sections together with the end of strut B2 fixed therebetween.

The other end of strut B2 indicated at 136 extends to a position at the rear face of the intermediate section to which tip section T2 is connected. For reference purposes we will assume the intermediate section to be section U which is in turn connected to center section R. The inner ends of tip section T2 have thereon fittings 138 and 140 which are adapted to make connection with a corresponding pair of fittings 142 and 144. (See FIGS. 18 and 19.) The details of this arrangement constitute a construction similar to the connection between fittings 32 and 34 shown in FIGS. 3 and 7. It will be understood that no invention resides in the particular means that may be used as this is a mere mechanical expedient adapted to make suitable connection between the elements involved.

The connection between fitting 136 at the inner end of strut B2 and the rear of intermediate section U may be the same as the connecting arrangements shown in FIGS. 3 and 6 in which fitting 54 is connected to fitting 60 by bolt 62.

In summary, it will be seen that I have provided an antenna construction in which the tip sections are of novel formation permitting the tip sections to be nested or stacked in a minimum amount of space for shipping and in which the tip sections are individually braced to withstand the forces to which they will be subjected in use, all coupled with a new and novel means of affixing tip sections to the center or intermediate section as the case may be whereby the tip sections will have the same or better rigidity than that found in the much bulkier tip sections of the prior art constructions.

It is my intention to cover all changes and modifications of the example of the invention herein chosen for purposes of the disclosure which do not constitute departures from the spirit and scope of the invention.

I claim:

1. An antenna comprising a central structure of depth, said structure having a continuous circumferential symmetrical front member and a continuous circumferential symmetrical rear member spaced from said front member, a plurality of rigid bracing members connecting said front and rear members to maintain them in fixed spaced relation, a plurality of identical tip sections attached to said circumferential front member and to each other to form a continuous circumferential border of tip sections around said front member, bracing means at the rear side of each said tip section, said bracing means located along the radial edges thereof and a plurality of supporting struts each running from said rear bracing means to the circumferential rear member.

2. An antenna comprising a central structure of depth, said structure having a continuous circumferential symmetrical front member and a continuous circumferential symmetrical rear member spaced from said front member, a plurality of rigid bracing members connecting said front and rear members to maintain them in fixed spaced relation, a plurality of identical tapered tip sections secured to the said front member to form a continuous circular border of tip sections surrounding said central structure, each said tip section being connected to its adjacent tip section, bracing means for each tip section to prevent deflection of said tip section, said bracing means located at the rear side of said tip section along the radial edges thereof and a plurality of struts each extending from a point between the bracing means of adjacent tip sections in a radial and rearward direction to said circumferential rear member thereby to maintain said tip sections in fixed relation with respect to said central structure.

3. An antenna comprising a central structure of depth, said structure comprising an inner core unit of two sep-

arable identical braced units with a polygonal periphery, an outer section comprising a plurality of segments surrounding said core unit, each segment having an inner side, two radially extending sides and an arcuate outer side, said inner side of each said segment secured to one of the polygonal sides of the said inner core unit, said surrounding segments of said outer section together forming through their arcuate sides a circumferential front member, bracing behind said core unit and the surrounding segments of said outer section, said bracing comprising a circumferential rear member spaced from said circumferential front member, a plurality of identical tapered tip sections secured to the said front member to form a continuous circular border of tip sections surrounding said outer section, each said tip section being connected to its adjacent tip section, means bracing each said tip section against deflection, said bracing means located at the rear side and along the radial edges thereof and a plurality of struts each extending from a point between the bracing means of adjacent tip sections in a radial and rearward direction to said circumferential rear member thereby to further assist in maintaining said tip sections in fixed relation with respect to said central structure.

4. An antenna as set forth in claim 2, each said strut being connected to said bracing means at the rearmost part thereof and at a point intermediate the length of said bracing means.

5. An antenna as set forth in claim 2 in which the said bracing means along the radial edges at the rear of said tip sections is triangular in form and each said strut is connected to the apexes of adjacent pairs of said triangular bracing means on adjacent sections.

6. An antenna tip section adapted for rigid connection with a central structure and capable of being nested with other identical tip sections when removed from the central structure, each said tip section comprising a face which is a section of a paraboloid and having diverging radial sides and inner and outer sides, bracing means extending away from the face and along the rear of the radial sides only permitting said sections to be placed one on the other with the faces and bracing means in overlapping staggered relation, connectable elements integral with said bracing means remote from said face and intermediate the length of said bracing means and adapted for making connection at each radial side with a strut the other end of which may be secured to the rear of said central structure.

7. A tip section for an antenna comprising a rigid unitary structure having a face formed of a plurality of parallel transverse members welded to radial members, two of which constitute the sides of said section, truss braces secured to said radial members and extending to the rear of said section at right angles to said transverse members thereby providing a clear rear area permitting said sections to be nested together in staggered relation, fittings at the inner and outer corners of said section permitting connection with cooperating fittings on adjacent similar sections and with central supporting means, said truss braces including bushings close to the plane of the transverse members whereby adjacent sections may be bolted together intermediate their ends and other bushings at the part of each said brace remote from the face of said section whereby the end fitting of a strut may be bolted in position between aligned other bushings on adjacent sections.

8. An antenna tip section constituting part of a paraboloidal antenna and said tip section comprising two radially diverging side members and circumferentially extending inner and outer side members connected to said radially diverging side members, a paraboloidal face supported by said side members, bracing means for improving the rigidity of said tip section, said bracing means comprising two trusses, each extending to the rear of said section from said radially diverging sides and normal to said face, connecting means at the corners of said tip

section for making connection with corresponding connecting means at the corners of adjacently disposed similar tip sections, connecting means in said trusses located to the rear of said face whereby adjacent trusses of adjacent tip sections may be connected to each other and to a common strut and other connecting means intermediate the length of each said radially diverging side member whereby adjacent tip sections may be connected at such intermediate position.

9. A tip section as set forth in claim 8 in which said section is devoid of bracing between said trusses whereby said tip sections when disconnected from each other may

be nested together with the faces and trusses in overlapping staggered relation.

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