

Jan. 7, 1958

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2,819,463

VARIABLE ANGLE CONICAL ANTENNA

Filed Oct. 14, 1954

4 Sheets-Sheet 1

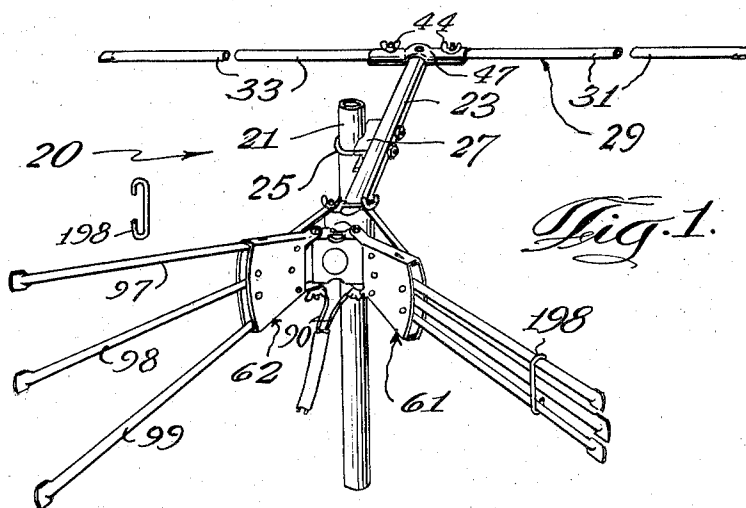


Fig. 1.

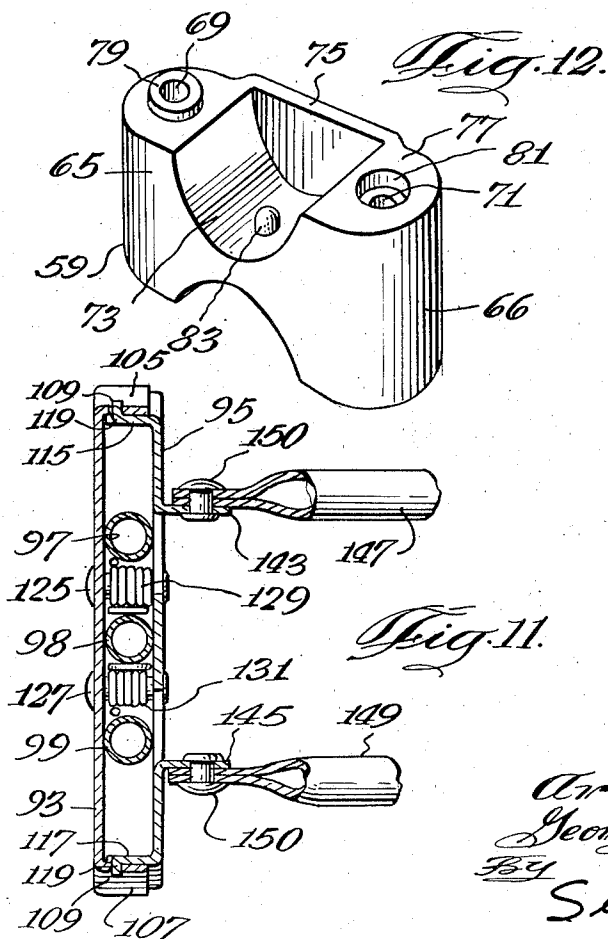


Fig. 13.

F.A. = 60°



Fig. 14.

F.A. = 110°

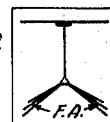


Fig. 15.

F.A. = 150°

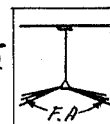
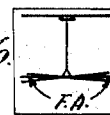


Fig. 16.

F.A. = 180°



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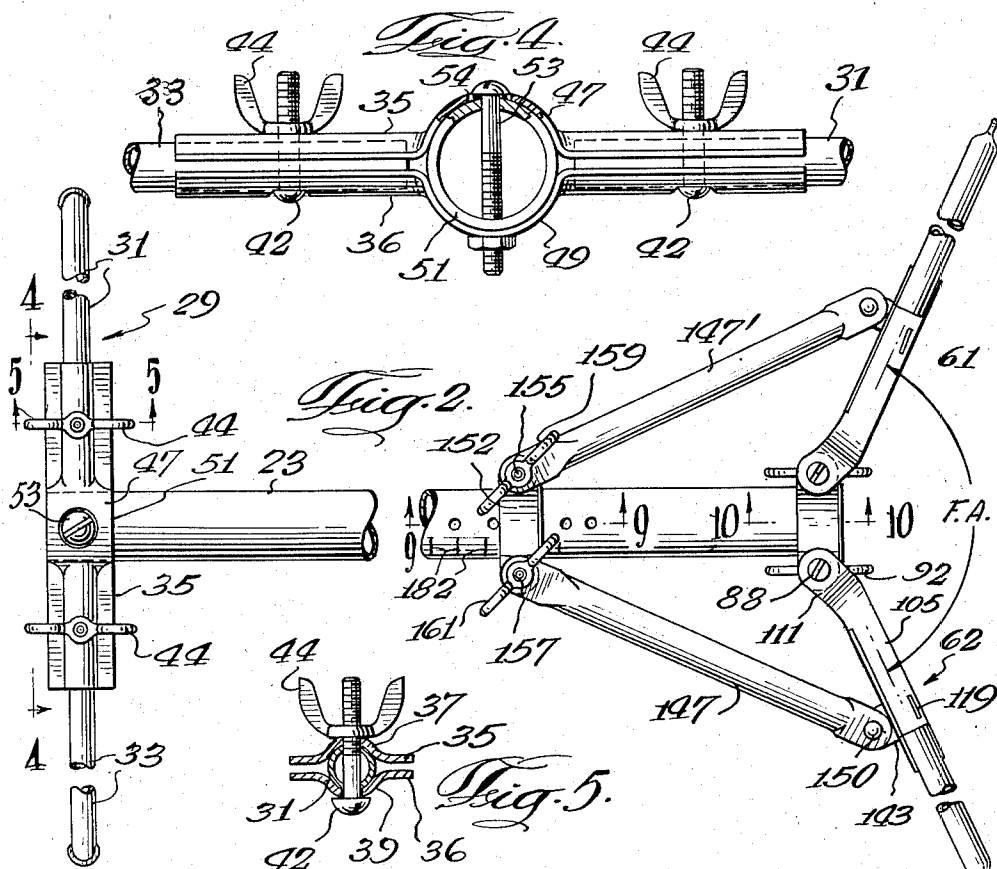
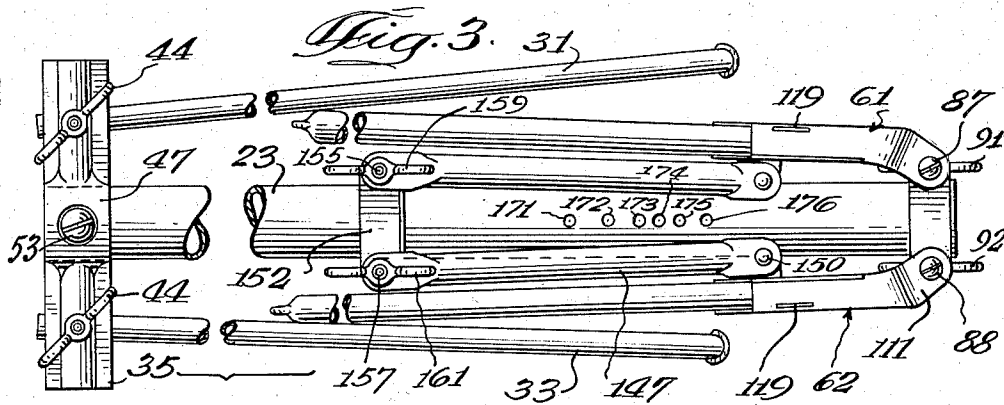
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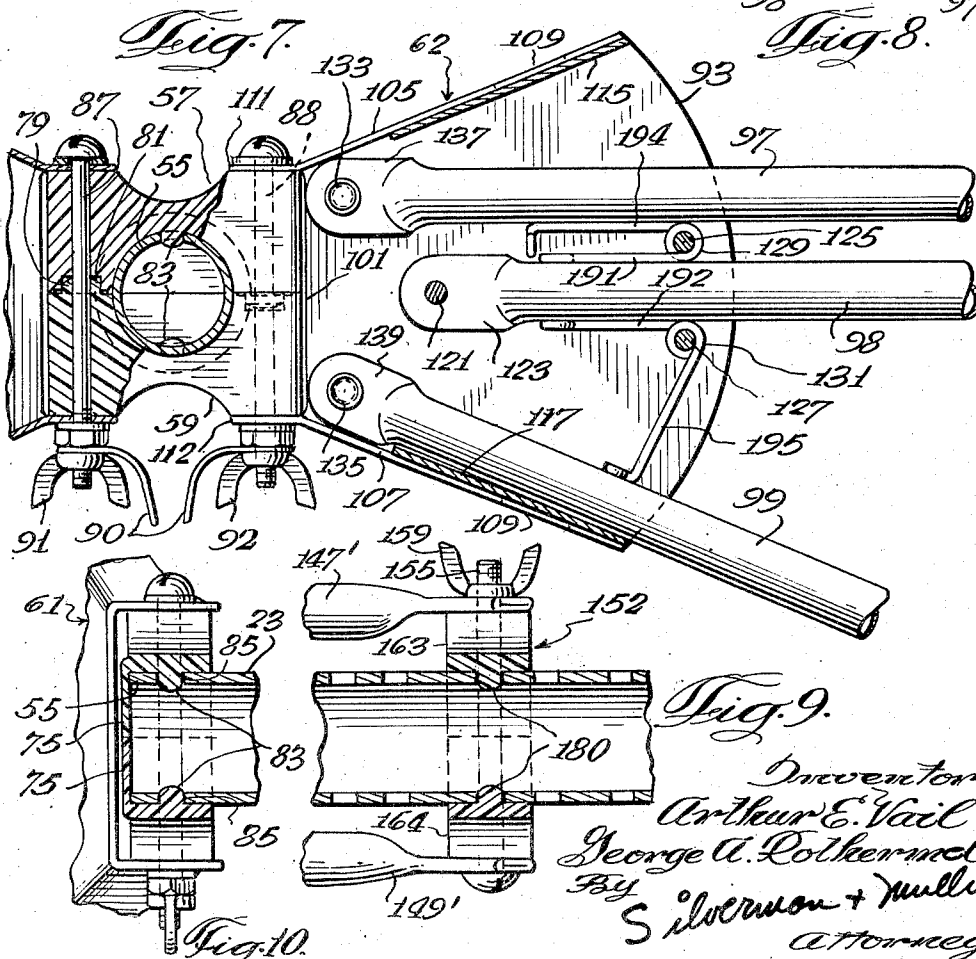
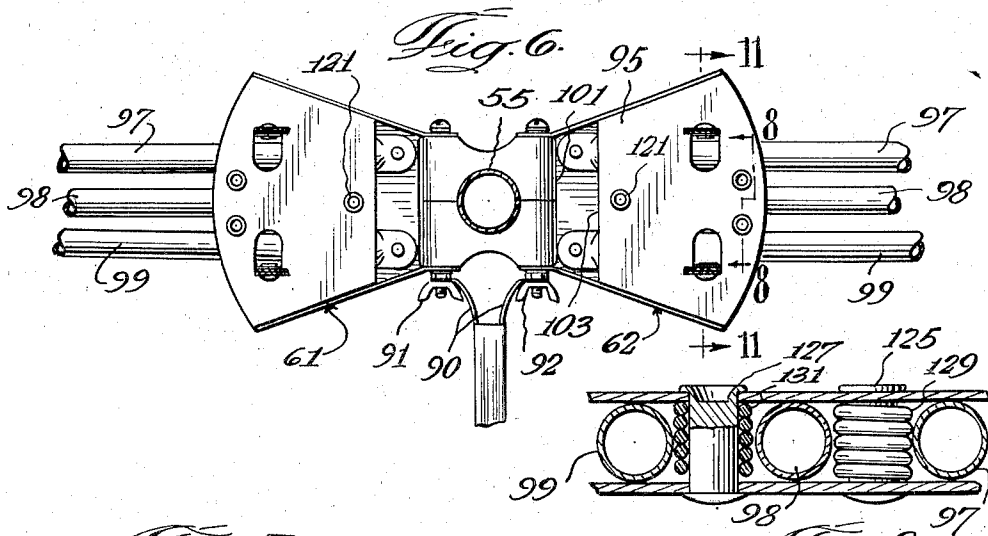
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VARIABLE ANGLE CONICAL ANTENNA

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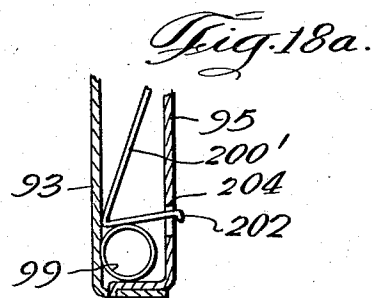
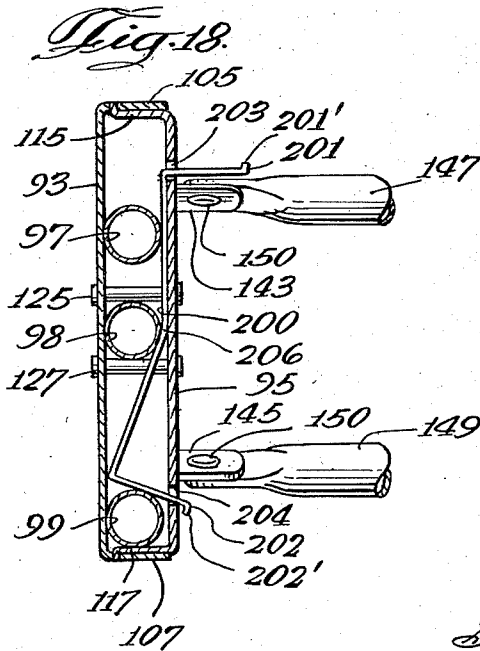
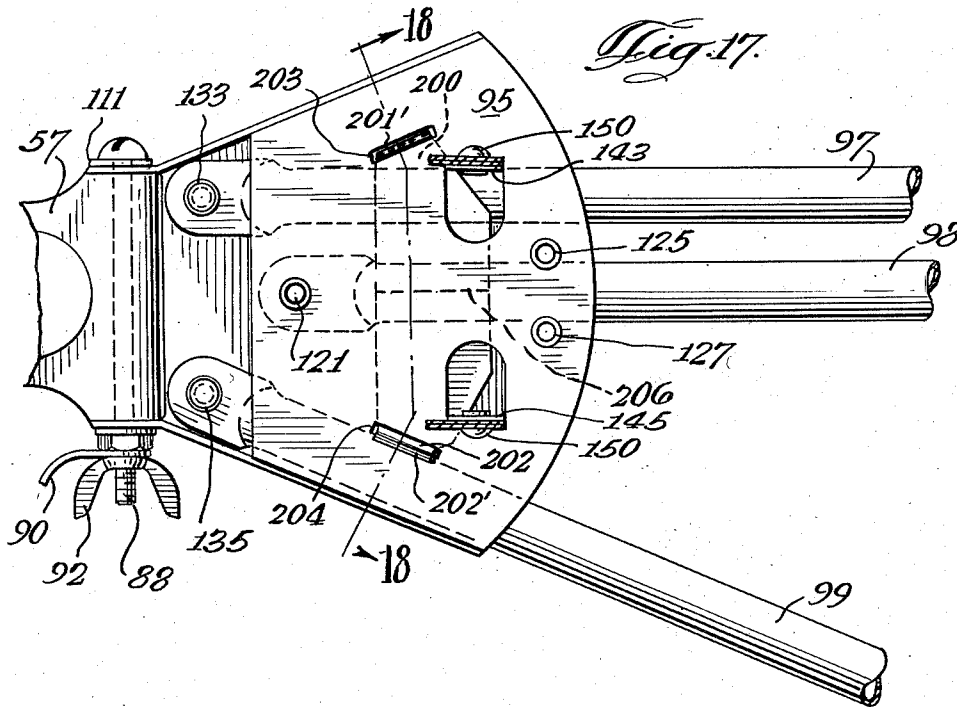
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VARIABLE ANGLE CONICAL ANTENNA

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4 Sheets-Sheet 4



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VARIABLE ANGLE CONICAL ANTENNA

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Application October 14, 1954, Serial No. 462,157

13 Claims. (Cl. 343—808)

This invention relates generally to antennas for the reception or transmission of high frequency energy and more particularly is concerned with the novel construction of a conical antenna in which the angular relationship between the active elements, that is, the opposite halves of the dipole elements, is capable of ready adjustment for a variety of different purposes.

The antenna described herein, while especially intended for use in the reception of high frequency television signals, is equally applicable for transmission and may be used in other than the television spectrum by merely varying the dimensions thereof.

The basic conical antenna is well-known and widely used. The ideal or theoretical structure is of course a pair of cones whose apices meet, the total overall length of which is a half wave-length of the particular frequency for which the antenna has been cut. Practical considerations have dictated modification so that the common conical structure consists of several fanned rods on each side of the center of the antenna, electrically connected at their joined ends and fed in the convention manner across the open space in the center of the antenna.

The good characteristics of the conical antenna which render it particularly useful for the reception of television signals is its broadband coverage enabling the antenna to give good gain for multiple frequencies (different channels), its excellent line match, and its relative economy when compared with complex structures usually used for fringe area television reception. Several disadvantages of the conical antennas heretofore available have prevented its use from being even more extensive than it is, and these will be enumerated hereinafter.

In general, an important object of this invention is the elimination of the disadvantages attendant upon the conventional conical antenna through novel construction and arrangement described hereinafter.

One important disadvantage of the conical antenna is that it has a broad horizontal pattern with loss of gain. Since the manufacturer of these antennas cannot build into the conical antenna a structure which will be best for any location at which the same may be used, and since it is impractical for every antenna to be "tailor-made" for the particular location, the usual conical antenna is at most a compromise. It is a guess at the best characteristics which it is hoped will be had in the general area used.

This disadvantageous characteristic of broad horizontal pattern is accompanied by rather strong lobes which not only may decrease the effectiveness of the antenna on certain channels but as well may be the source of annoying ghosts and interference on the desired channel.

Patterns of conical antennas are capable of change and adjustment through the variation of the angular relationship between the dipole halves—that is to say—by changing the angle of forward V, the pattern may be adjusted for various locations. Conical antennas available heretofore, however, have not been capable of ready adjustment

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for changing of the pattern, and it is an important object of the invention to provide a conical antenna in which the active elements may readily be adjusted and fixed in any desired position, in the field while installing the same.

Other conical antennas have been difficult to assemble and ship because of the nature of the structure. Where shipped knocked down, the labor required of the installer is quite substantial and takes much time. Where shipped with portions preassembled, the antennas required considerable volume resulting in large packing boxes and the utilization of much storage and shipping space.

This invention, while providing for the adjustability of the active elements of the conical dipole, still provides a structure where the entire antenna may be folded into very small space, but in substantially completely assembled condition, so that the same may be expanded to its final arrangement in a manner of seconds merely by moving the parts to extended condition and tightening a few nuts.

In connection with the advantageous arrangement of permitting adjustment of the active elements of the antenna, it is pointed out that where an antenna is being used in a location at which there is a considerable angle between stations on different channels, the angular relationship between active elements can be adjusted so that one channel may be picked up on a major lobe and another channel picked up on a minor lobe, thereby eliminating the necessity of a second antenna pointing in another direction or eliminating as well antenna rotating means. Through adjustment the strength of the minor lobe as well as its direction can be varied to suit the needs of the location.

Likewise, where a given channel is weak, adjustment of the active elements of the antenna to change the relative angle therebetween enables the antenna to be adjusted for optimum performance on that channel. Ghosts can be easily eliminated by the adjustment of the pattern to provide a null in the direction from which the ghost is received.

Co-channel interference can also be eliminated through adjustment of the active elements.

The invention likewise contemplates the construction of a conical antenna in which the antenna may be shipped or stored with its active elements folded back and substantially parallel with its support boom, while still connected therewith. An object of the invention is the provision of structure enabling this to be done.

Another object of the invention lies in the provision of structure enabling the dipole elements to be moved from a collapsed to a fanned position, and vice versa whereby to save storing space and assembly time while providing a rugged and durable structure. In connection with this object it is also an additional object to provide means locking the dipole elements in fanned condition and to provide means whereby the removal of a retaining clamp from the collapsed dipole elements will cause them automatically to snap out to fanned and locked position.

Another object of the invention is to provide a novel connection between the active halves of the antenna and a sleeve member slidable along the boom to a plurality of calibrated positions, and providing means for locking the slidable member in any desired position.

Still a further object of the invention lies in the provision of novel structure of the so-called "butterfly" sections of the antenna within which the dipole elements are retained.

Other objects not specifically set forth herein in detail are the provision of a conical antenna which is capable of ready manufacture without complicated and expensive apparatus; the provision of an antenna having the attributes set forth above which can be made fool-proof so

that the installer will not assemble the same backward or in error; the provision of an antenna which is pleasing in appearance; the provision of an antenna of this character which is readily mass-produced for sale at low prices; the provision of a conical antenna which is easily stacked in multiple bays and readily fed; the provision of an antenna structure which is not likely to become loose or vary in its adjusted position, either as to the antenna as a whole or as to its parts.

Many other objects and advantages of the antenna, both mechanical and electrical will occur and become apparent to those skilled in the antenna art, as a detailed description of the invention proceeds, in connection with which a preferred embodiment with variations has been illustrated in the accompanying drawing and explained in the accompanying specification to the end that a complete and thorough understanding of the invention may be had as required by the patent law.

It is to be emphasized that the antenna structure is readily capable of variation in dimensions and proportion and minor details, without in any way departing from the spirit or scope of the invention. Certainly the adaptation of the antenna for different portions of the spectrum will result in minor problems arising readily capable of solution within the teachings of the invention as set forth hereinafter. Variations in the number of active elements, the manner of connecting the transmission line, and the like are certainly contemplated herein, although not illustrated, or deemed necessary of explanation. In the drawings, in which like or similar characters represent the same or equivalent parts throughout the several figures of the drawings:

Fig. 1 is a perspective view of a conical antenna of single bay construction embodying the invention, mounted upon a support post in conjunction with a reflector element.

Fig. 2 is a top plan view of the antenna of Fig. 1 on an enlarged scale, portions being foreshortened for enabling clear illustration.

Fig. 3 is a top plan view of the antenna of Fig. 1 completely folded for storage or shipping.

Fig. 4 is a sectional view taken through the reflector mounting along the line 4—4 of Fig. 2 and in the indicated direction.

Fig. 5 is a sectional view taken through the reflector mounting along the line 5—5 of Fig. 2 and in the indicated direction.

Fig. 6 is an elevational view with portions shown in section, looking at the dipole portion of the antenna from the rear thereof forwardly in the direction the antenna is pointed, showing the backs of the "butterfly" sections.

Fig. 7 is an enlarged view similar to the right half of the view of Fig. 6, but with the butterfly section uncovered and one of the dipole rod elements moved to fanned position.

Fig. 8 is a sectional view taken through the butterfly section along the line 8—8 of Fig. 6 and in the indicated direction.

Figs. 9 and 10 are sectional views taken through the boom along the lines 9—9 and 10—10 of Fig. 2 and in the indicated direction for the purpose of illustrating the details of the insulating end blocks and the adjusting sleeve.

Fig. 11 is a sectional view taken generally along the line 11—11 of Fig. 6 and in the indicated direction.

Fig. 12 is a perspective view of one half of the end insulating block assemblage to show the details of construction thereof.

Figs. 13 through 16 are diagrammatic views showing the various angles of adjustment of the antenna for optimum performance on different channels, looking at said antenna generally in plan.

Fig. 17 is a view similar to that of the right hand portion of Fig. 6 but illustrating a modified form.

Fig. 18 is a sectional view through Fig. 17 along the line 18—18 and in the indicated direction.

Fig. 18a is a view similar to that of Fig. 18 but showing a modification.

Generally the invention consists of a conical antenna comprising a boom and mast, a reflector element, preferably foldable, on the back end of the boom, and a pair of butterfly sections on the front end of the boom. The butterfly sections each has means pivotally mounting the same to an insulating block or blocks secured to the front end of the boom and is formed as a triangular or segment-like socket or pocket within which are disposed three half-dipole rods, normally collapsed and held parallel one to the other, but readily capable of being fanned to spread out condition and locked in that condition. Back of the front insulating block is a sliding block or sleeve, linked to the butterfly sections and capable of being secured to various positions along the boom so that moving it to these various positions varies the V angle between the butterfly sections and hence the forward angle between active elements of the conical antenna.

Referring now specifically to the drawings, the reference character 20 is used generally to designate the antenna, and while the conical portion is capable of being readily used by itself, it is preferred that the parasitic reflector element be included as a part of the antenna for better directivity and rejection of rear signals. Thus the character 20 in the specification, as well as the word "antenna" will include the reflector element, but in the claims reference to "antenna" will not necessarily include parasitic elements unless stated.

The antenna 20 is illustrated in Fig. 1 as a single bay, although multiple bay installations are possible. There is an upright standard or mast 21, preferably of steel, having a boom 23 secured thereto in any suitable manner. For example, a U-shaped shackle 25 having threaded ends may be clamped about the mast 21 through the use of an indented or serrated edge channel member 27 interposed between boom and mast and held in place by any suitable fastening means such as bolts with usual lock washers and the like.

At its rear-most end the boom is provided with a cross member designated generally 29 which forms a parasitic antenna element. It is slightly longer than the projected maximum length of the principal driven elements when fully extended, considered on a plane at right angles to the boom, and hence is a reflector. The reflector 29 (as it will hereinafter be termed) is formed of a pair of light weight tubular members 31 and 33 each of which is substantially half the overall length of the reflector 29. Each of the members 31 and 33 has its inner end engaged between the clamp members 35 and 36 which are embossed lengthwise as indicated at 37 and 39 in Fig. 5 to provide elongate facing concave grooves for seating the members 31 and 33. The clamp members 35 and 36 are provided on each side of the boom with bolts 42 passing through suitable holes formed in the clamp members as well as the tubular members 31 and 33 to the threaded ends of which are secured thumb nuts 44. Loosening the thumb nuts 44 permits the clamping members 35 and 36 to be spread apart so that the tubular members 31 and 33 may be moved from their extended condition as illustrated in Figs. 1, 2, 4 and 5 to a folded condition as illustrated in Fig. 3. This obviously reduces the size of the antenna 20 to enable packing same in a small package, but still assembled.

The clamp members 35 and 36 are further embossed with transverse arcuate grooves as indicated at 47 and 49 the configuration of which is such as to matingly engage with the rear end 51 of the boom 23. A bolt 53 passes through the entire assembly and secures the reflector 29 to the boom by means of a nut tightly screwed to said bolt. The head of the bolt is arranged to pass through an enlarged opening 54 in the member 36 so that said member is free to move when the thumb nuts 44 are

loosened. Any other suitable fastening means may be used, such as rivets and the like.

The forward end of the boom 23 is designated 55 (see Figs. 6, 7 and 10) and said forward end is capped by an assembly of two insulating blocks 57 and 59 which are identical in construction, as will be explained, and together provide pivotal mounting for the butterfly sections designated 61 and 62. One of these blocks is illustrated in perspective in Fig. 12. This illustrated block is designated as 59 because if assembled to its opposite mate as disposed in the figure it would be the bottom block.

Design configurations tending to reduce the weight of the block 59 have not been shown for simplicity, but even in the form illustrated it will be obvious that the block provides a compact and efficient member for the purposes intended. The horizontal sectional configuration is somewhat oval, providing opposed bushing-like solid portions 65 and 66 each having a central passageway bored there-through as indicated at 69 and 71. Between the bushing portions 65 and 66 there is formed a semicylindrical recess 73 the end of which is closed off by a web 75. Since this is the bottom block 59, the recess 73 is concave upward, and the surface which will bear against the mating block 57 is the upper surface 77. An upwardly extending annular protrusion 79 surrounds the top opening of passageway 69 while an identical annular indentation 81 surrounds the top opening of the passageway 71. The bottom of the recess 73 has a central upwardly extending pin 83 therein.

Since the block 57 is identical in structure, when placed on top of the block 59, the male and female parts 79 and 81 respectively of the respective blocks will guide and seat the blocks in perfect engagement. The end webs 75 will abut to completely close off the end 55 of the boom 23 as shown in Fig. 10. The combined recesses 73 together will form a cylindrical socket of the same diameter as the boom 23 and the pins 83 will enter perforations 85 provided top and bottom of the boom end 51 for the reception thereof. The mating engagement of male and female parts 79 and 81 is best illustrated in Fig. 7.

The blocks 57 and 59 are held in assembly upon the boom end 55 by means of long bolts 87 and 88 having rounded slotted heads on their upper ends, and being secured by nuts on their lower ends. Suitable washers are used as illustrated, and the bolts 87 and 88 provide convenient terminals for the transmission line 90, which is attached by means of thumb nuts 91 and 92.

As previously stated the combined assemblage of blocks 57 and 59 (which may together be termed a block or single insulating member for purpose of description in the claims) provides the pivotal mounting for the butterfly sections 61 and 62. Each of the sections is identical and hence only one will be described in detail. The section 62 is formed of light weight sheet metal such as aluminum and has an outer member 93 and an inner member 95 both of generally shallow channel cross sectional configuration matingly engaged one within the other and secured together to form a socket for the rod members 97, 98 and 99 which are mounted therein.

The outer member 93 has a configuration in the vertical plane somewhat like a segment of a circle with its innermost tip removed. The inner member is substantially congruent, but its innermost portion is foreshortened more than that of the outer member. For illustration, the innermost edge (closest to the block assembly 57-59) of the outer member 93 is designated 101 while that of the inner member 95 is designated 103.

The outer member 93 has top and bottom right angle bent walls 105 and 107 each of which is provided with an elongate slot 109 adjacent its outer end (furthest from the block assembly 57-59). An extension of the walls 105 and 107 extending inwardly past the edges 101 is widened and pierced to provide top and bottom ears

111 and 112 pivotally secured beneath the head and nut respectively of the bolt 88.

The inner member 95 forms a cover for the member 93 as perhaps best indicated in the Fig. 11. It also has right angle bent walls 115 and 117 of such dimension and so arranged as to enable the inner member 95 to telescopically engage within the member 93 with the opposite walls face to face. There is a small ear or lug 119 struck from the edge of each wall which snaps into the respective slots 109 to lock the members 93 and 95 together. The butterfly section 62 is further maintained in assembly by means of a central rivet 121 which passes through both members 93 and 95 and through the flattened end 123 of the central rod 98. With the body of the rod 98 tightly sandwiched between the inner faces of members 93 and 95, the said members are maintained in spaced relationship a distance apart equal to the diameter of the rod.

In addition, two more rivets 125 and 127 pass through the assemblage on either side of the central rod 98 having coiled springs 129 and 131 respectively mounted thereon for a purpose presently to be described. Thus the butterfly section 62 is maintained in rigid assembly and the center rod 98 is fixed relative to the assemblage of members 93 and 95.

The outer rods 97 and 99 are pivotally secured to the inner face of the member 93 by rivets 133 and 135 passing through their flattened ends 137 and 139. This securement is between the edge 103 and the edge 101 and hence from the rear as viewed in Fig. 6 these rivets and the ends 137 and 139 are exposed. The rods are so secured that they may be fanned out to the condition illustrated in Fig. 1 in which case rods 97 and 99 lie in parallel engagement with the inner surfaces of the walls 115 and 117 respectively. In Fig. 7, the rod 97 is shown substantially parallel with the rod 98 while the rod 99 is shown fanned outwardly. With all of the rods parallel the antenna 20 may be folded, insofar as the butterfly sections themselves are concerned, as best illustrated in Fig. 6, Fig. 11, and on the right hand side of Fig. 1 (section 61).

The structure permitting the fanning and gathering of the active elements of the antenna will be described in some detail hereinafter. It is first desired to describe the constructional features which enable varying the angle subtended between the forward faces of the butterfly sections.

In referring to active elements, it is intended to mean the rods 97, 98 and 99 which are electrically connected with the bolt 88 (those rods of the other section being likewise electrically connected to the bolt 87) such that they are either driven by the transmission line or energize the same in the case of reception. The rods on opposite sides of the antenna are like dipole halves, and in the practical embodiment are also formed of lightweight metal tubing, such as aluminum or magnesium and alloys thereof.

As pointed out, the butterfly section 62 is pivotally mounted upon the block assembly 57-59 by means of the ears 111 and 112 and bolt 88. Unless restrained, the section 62 is thus readily capable of rotating from a position somewhat as illustrated in Fig. 3 where it is parallel with and alongside the boom 23 counterclockwise to a position 180° or more away. The position of the butterfly section 62 illustrated in Fig. 2 would be an intermediate position.

For purposes of this invention, and to provide a practical structure, the section 62 is arranged to rotate about its pivot defined by bolt 88 simultaneously with the mirror rotation of the section 61 about its bolt 87, so that at all times there will be symmetry in the driven or active portion of the antenna 20. A novel linkage is provided which causes movement of one section to be duplicated in a mirror movement of the other section,

Likewise, in order to provide a sturdy and durable antenna to withstand weather and wind, the invention includes structure for positively locking the sections 61 and 62 in various positions of different forward or V angle. In Figs. 13 through 16, four different forward angles are illustrated, being 60° to 180° respectively.

Hereinafter, for purposes of simplification, forward angle of the antenna will be defined as that angle subtended between the planes of the sections 61 and 62, and designated FA in Fig. 2 and Figs. 13 through 16.

The inner member 95 is provided with outwardly struck lugs 143 and 145 integral therewith and to the lugs there are pivotally secured the ends of links 147 and 149 respectively by means of rivets 150 or the like. In the interest of economy and light weight, the links 147 and 149 are formed of aluminum tubing with flattened ends. At their opposite ends the links 147 and 149 are pivotally secured to top and bottom respectively of what will be termed an adjusting sleeve 152. The sleeve 152 is made of electrically non-conductive material to insulate the butterfly sections 61 and 62 from the boom 23, although it is possible to use a metallic sleeve 152 and insulating links 147 and 149. While the sleeve 152 may be in the form of simple split clamp having bolts 155 and 157 on opposite sides of the boom, and capable of being clamped to the boom by the thumb nuts 159 and 161 respectively, another structure is preferably used. In Fig. 9 it will become apparent that the sleeve 152 is constructed of two halves, upper and lower, designated 163 and 164 which are identical in every respect to the blocks 57 and 59 with the exception of the webs 75 which have been omitted.

Thus the sleeve 152 is preferably an insulating block capable of being slid along the length of the boom 23 to vary the forward angle of the active antenna elements. With the links 147 and 149 pivotally connected to the sleeve 152 on one side of the boom, and the links 147' and 149' of the section 61 extending and connected to the sleeve on the other side of the boom upon bolt 155, any sliding movement of the sleeve 152 along the boom is accompanied by variations of the forward angle of the active antenna elements in a symmetrical manner.

Loosening the thumb nuts 159 and 161 is all that is required to permit this movement. It is desirable, for example, for storing or shipping the antenna to move the sleeve 152 its maximum extent away from the front of the boom, thereby causing the sections 61 and 62 to compactly fold together parallel with and alongside the boom as shown in Fig. 3.

In order to lock the antenna in any given position of forward angle, the boom is provided with a series of perforations along its length, both top and bottom. These are designated 171 to 176 and the entire series is illustrated best in Fig. 3. Top and bottom perforations are identical. It will be recalled that blocks 57 and 59 had pins 83 protruding from the recesses 73 and engaging suitable perforations 85 at the forward end of the boom. The halves 163 and 164 likewise have pins designated 180, intended to cooperate with the perforations 171 to 176. With the thumb nuts 159 and 161 tightened, it is impossible to move the sleeve 152 (and hence change a set forward angle) without breaking off the pins 180.

The various forward angles provided by the different positions can be calibrated and marked alongside the perforations 171 to 176 as indicated at 182 in Fig. 2. Different peaking is obtained in the various positions. As an example, a practical structure of the invention for television use was constructed so that with the pins 180 in the perforations 176 the forward angle was approximately 60° (Fig. 13), the antenna was receptive to all channels from 2 to 83, but particularly peaked at all of the ultra high frequency channels 14 to 83. With the pins 180 in the perforations 175, the forward angle was approximately 110° (Fig. 14), the antenna was re-

ceptive to channels 2 to 13 but peaked for the higher of these channels, 7 to 13. With the pins 180 in the perforations 173, the forward angle was approximately 150° (Fig. 15), the antenna was receptive to channels 2 to 13 and peaked for substantially equal performance on all channels. With the pins 180 in the perforations 171, the forward angle was approximately 180° (Fig. 16), the antenna was receptive to channels 2 to 13 but peaked for the lower of these channels, 2 to 6.

The intermediate positions gave alternate peaking positions to adjust for ghosts, interchannel interference, emphasis or de-emphasis of side lobes, and variation of aperture.

It can be appreciated that the antenna of the invention is highly flexible as to adjust and use and is easily stored, shipped, installed and peaked without expenditure of substantial time or effort, or unusual skill. It will further be appreciated that the structure is highly simplified, provides a rigid and durable antenna capable of efficient service for a maximum of performance.

Note that while four links are used connecting the butterfly sections to the adjusting sleeve, only two need be used, one on each side of the boom. Four provide greater rigidity and eliminate binding.

As previously stated, both in the specification and in the objects, the invention also lies in the construction enabling the folding and fanning of the rods comprising the active elements.

In the embodiment thus far described, the coil springs 129 and 131 each have two arms. One arm 191 and 192 of each engages against the side of the rod 98. The other arm 194 and 195 of each is biased to move to a position where it is at right angles to the respective rods 97 and 99 in fanned out position. Thus, with the rods folded, as is the rod 97 in Fig. 7, the arm 194 is parallel with the rod 97, biased against its inner side, and prevented from moving in a clockwise direction about the rivet 125 so long as the rod is held as shown. The rod 99 is illustrated as having been forced to its fanned out position by counterclockwise movement of the arm 195 to the position shown, at right angles to the rod 99. Obviously since the spring arm 195 assumes this final position, the rod 99 is locked in fanned out position and cannot be folded to a position parallel to rod 98 without deforming the arm 195 or simply pushing said arm in a clockwise direction out of right angle engagement with the rod 99.

The structure described is advantageous in that when the rods are folded as on the right hand side of Fig. 1 illustrating section 61, they may be held in non-rattling condition by a simple wire C-clip engaging all three rods. Upon removal of the C-clip the outer rods snap to fanned out position, automatically, and lock themselves in that position. This quick setting up of the antenna without tools saves much assembly and adjustment time in the field, and enables the antenna to be installed upon a mast in folded condition (while easy to manipulate) and then fanned out after everything has been tightened.

The modified form of the butterfly section 62' illustrated in Figs. 17 and 18 is capable of alternate use with the antenna 20. It is of the same exterior construction as the butterfly sections described, and is likewise mounted on the block assemblage 57—59 in the same manner. The rods 97, 98 and 99 are mounted in the identical way through the use of the rivets 121, 133 and 135. Rivets 125 and 127 fix the position of the center rod 98, but it will be seen that they are somewhat closed together since the springs 129 and 131 have been eliminated. In place of these two springs there is provided a flat leaf spring 200 which extends substantially across the interior surface of the inner covering member 95, being bent at right angles thereto at its ends as shown at 201 and 202, the ends extending respectively through slots 203 and 204 provided in the member 95. This spring is sandwiched between the rods and said interior face, and held substantially flat thereagainst when the rods are in folded condition.

It will be apparent that the spring 200 is formed so that its normal unflexed condition is V-shaped. The halves of the spring are biased so that they will flex along a sort of hinge line at the spring center, this line being designated 206 in Fig. 17. In view of the manner in which the spring 200 is mounted, when the rods are folded, the halves are pressed to the member 95. The lengths of the halves is such that fanning the rods out will carry them beyond the spring ends permitting the spring to move toward its normal position, thereby blocking return movement of the rods and hence locking them in place.

Thus, in Fig. 18, the upper half of the spring is substantially engaged against the member 95, because the rod 97 is in folded condition alongside the center rod 98. It supports the upper half, being in the path of the movement the half will be required to take to move to its normal position. As for the lower half, however, note that the rod 99 has been moved to fanned out position, clearing the end 202 and thus permitting the said end to spring down to the position shown. The lower half of the spring 200 has thus moved in a clockwise direction about the center 206 until its movement is limited by engagement with the inner face of the member 93 and the side of the rod 99. It is preferred that there be wedging engagement between the ends 201 and 202 and the respective rods 97 and 99 in fanned out condition, to hold them firmly.

Any attempt to move the fanned rods inwardly is resisted because such movement is blocked by the presence of the ends 201 and 202. It is preferred that the angle between the said ends and the path of the movement of the rods be approximately 90° or even such as illustrated in Fig. 18-a so that there is no likelihood of the inner movement of the rod driving the ends 201 or 202 back out of their respective slots and thereby freeing the rods. Attempted folding movement of the rod 99 of Fig. 18-a would merely wedge the spring 200 tighter against the inner face of the member 93.

This structure, it will be noted is not automatic in that the rods 97 and 99 must be manually fanned out. The locking of the rods in position is, however, automatic. Also, the necessity for reaching into the interior of the butterfly section in order to release the locking springs of the previously described embodiment has been eliminated. In order to fold the antenna, all that is required is to lift the ends 201 and 202 using one's fingers, which frees the rods 97 and 99. Convenient lips 201' and 202' are provided for enabling this lifting more readily to be accomplished.

It is believed that the invention has been fully explained such as to enable one skilled in the antenna art to construct and use variable angle conical antennas embodying the same. The great advantages of the invention lie, not only in the novel features of the structure per se but as well reside in the greatly extended utility of the conical antenna of the invention over the conical antennas heretofore used and available. Through the invention, the conical antenna's disadvantages have been turned to advantages, especially in the use of side lobes for enabling reception of different channels from widely angled different directions, and in the peaking for increasing gain of certain weak signals. The versatility of the antenna constructed in accordance with the invention has made the antenna desirable in areas where its use heretofore was impractical.

Obviously the basic invention can take many forms other than described herein, and may differ in minor details and dimensions without in any way departing from the spirit or scope of the invention as defined in the appended claims.

What it is desired to secure by Letters Patent of the United States is:

1. An antenna comprising a boom adapted to be supported horizontally upon a suitable standard, an insulating block secured to the forward end of the boom, a pair of opposed conical dipole elements each comprising a plu-

ality of outwardly extending rods, means retaining the rods of each conical dipole element in assembly, said retaining means of each element being pivotally secured to said block on opposite sides thereof and providing means for connecting a transmission line to said elements, and means for bracing said elements relative to said boom in any of a plurality of positions providing different forward angles of said dipole elements, said retaining means comprising outwardly diverging segment-shaped metallic pockets having the rods secured therein, whereby all of the rods of each element are electrically connected at their inner ends, each pocket having hinge ear means at the end thereof next adjacent the boom, the block having vertically arranged hinge pin means on opposite sides thereof and connected with said ear means to provide said pivotal securement.

2. An antenna comprising a boom adapted to be supported horizontally upon a suitable standard, an insulating block secured to the forward end of the boom, a pair of opposed conical dipole elements each comprising a plurality of outwardly extending rods, means retaining the rods of each conical dipole element in assembly, said retaining means of each element being pivotally secured to said block on opposite sides thereof and providing means for connecting a transmission line to said elements, and means for bracing said elements relative to said boom in any of a plurality of positions providing different forward angles of said dipole elements, said retaining means comprising outwardly diverging segment-shaped metallic pockets having the rods secured therein, whereby all of the rods of each element are electrically connected at their inner ends, each pocket having hinge ear means at the end thereof next adjacent the boom, the block having vertically arranged hinge pin means on opposite sides thereof and connected with said ear means to provide said pivotal securement and there being sufficient clearance between block and pockets to permit rotation of said pockets from positions alongside of said boom to the rear of the block to any of positions extending angularly forward of said block.

3. An antenna comprising a boom, means for supporting the boom in horizontal disposition upon a standard, an insulating block secured to the forward end of the boom and having vertical metallic hinged butterfly sections pivotally mounted at their inner ends respectively on opposite sides thereof and insulated one from the other, each section provided with a plurality of outwardly extending rods having their inner ends secured to the said section and providing thereby opposed conical dipole elements, means for bracing the said butterfly sections in any of a plurality of different forward angles.

4. An antenna comprising a boom, means for supporting the boom in horizontal disposition upon a standard, an insulating block secured to the forward end of the boom and having vertical metallic hinged butterfly sections pivotally mounted on opposite sides thereof and insulated one from the other, each section provided with a plurality of outwardly extending rods having their inner ends secured to the said section and providing thereby opposed conical dipole elements, means for bracing the said butterfly sections in any of a plurality of different forward angles, said bracing means including a link extending from a butterfly section to said boom and being capable of securement to said boom at any of a plurality of positions.

5. An antenna comprising a boom, means for supporting the boom in horizontal disposition upon a standard, an insulating block secured to the forward end of the boom and having vertical metallic hinged butterfly sections pivotally mounted on opposite sides thereof and insulated one from the other, each section provided with a plurality of outwardly extending rods having their inner ends secured to the said section and providing thereby opposed conical dipole elements, means for bracing the said butterfly sections in any of a plurality of different forward

angles, said bracing means including a link extending from a butterfly section to said boom and being capable of securement to said boom at any of a plurality of positions, said boom having a slidable sleeve thereon rearward of said front block and the boom end being pivotally secured to the sleeve, and said sleeve having means for fixing the sleeve in any of said positions.

6. An antenna comprising a boom, means for supporting the boom in horizontal disposition upon a standard, an insulating block secured to the forward end of the boom and having vertical metallic hinged butterfly sections pivotally mounted on opposite sides thereof and insulated one from the other, each section provided with a plurality of outwardly extending rods having their inner ends secured to the said section and providing thereby opposed conical dipole elements, means for bracing the said butterfly sections in any of a plurality of different forward angles, a slidable sleeve capable of being secured in any of a plurality of positions along the boom rearward of the front block, said bracing means comprising links of equal length pivotally connected between the respective butterfly sections and opposite sides of said sleeve such that movement of the sleeve along the boom will pivot the butterfly sections in mirrored identical rotation about vertical axes to vary the forward angle of the opposed conical dipole elements.

7. An antenna comprising a boom, means for supporting the boom in horizontal disposition upon a standard, an insulating block secured to the forward end of the boom and having vertical metallic hinged butterfly sections pivotally mounted on opposite sides thereof and insulated one from the other, each section provided with a plurality of outwardly extending rods having their inner ends secured to the said section and providing thereby opposed conical dipole elements, means for bracing the said butterfly sections in any of a plurality of different forward angles, a slidable sleeve capable of being secured in any of the plurality of positions along the boom rearward of the front block, said bracing means comprising links of equal length pivotally connected between the respective butterfly sections and opposite sides of said sleeve such that movement of the sleeve along the boom will pivot the butterfly sections in mirrored identical rotation about vertical axes to vary the forward angle of the opposed conical dipole elements, said sleeve and boom having cooperating pin and recess means at predetermined points along the length of the boom corresponding to different predetermined forward angles of the butterfly sections.

8. An antenna comprising a boom, means for supporting the boom in horizontal disposition upon a standard, an insulating block secured to the forward end of the boom and having vertical metallic hinged butterfly sections pivotally mounted on opposite sides thereof and insulated one from the other, each section provided with a plurality of outwardly extending rods having their inner ends secured to the said section and providing thereby opposed conical dipole elements, means for bracing the said butterfly sections in any of a plurality of different forward angles, a slidable sleeve capable of being secured in any of a plurality of positions along the boom rearward of the front block, said bracing means comprising links of equal length pivotally connected between the respective butterfly sections and opposite sides of said sleeve such that movement of the sleeve along the boom will pivot the butterfly sections in mirrored identical rotation about vertical axes to vary the forward angle of the opposed conical dipole elements, said sleeve comprising a pair of mating halves each having an opposed recess providing a cylindrical space for said boom, at least one recess having a pin extending into the said space and the boom having perforations along its length to receive the pin and fastening means extending between the halves capable of being loosened to separate the halves a sufficient amount to enable the pin to clear the perforations to be moved to

any desired position, the fastening means being capable of contracting the halves together at any position where there is a perforation for said pin to enter.

9. A conical antenna including a boom and a pair of butterfly sections pivotally mounted on the forward end of the boom and each insulated from one another, and means bracing the sections from the boom, each section comprising a pair of segment shaped members spaced apart to provide a pocket, a plurality of rod members extending outwardly of the section and sandwiched between the segment shaped members, at least one of said rod members being pivotally secured to said section and mounted for movement between positions at which the said rod member assumes maximum and minimum angles relative to the horizontal plane containing the axis of said boom, and means for locking the said rod member in its position of maximum angle relative to said horizontal plane comprising a spring secured to said section and having a biased portion adapted to move from non-blocking to blocking position as said rod member is moved from minimum angle to maximum angle position.

10. A conical antenna including a boom and a pair of butterfly sections pivotally mounted on the forward end of the boom and each insulated from one another, and means bracing the sections from the boom, each section comprising a pair of segment shaped members spaced apart to provide a pocket, a plurality of rod members extending outwardly of the section and sandwiched between the segment shaped members, at least one of said rod members being pivotally secured to said section and mounted for movement between positions at which the said rod members assumes maximum and minimum angles relative to the horizontal plane containing the axis of said boom, and means for locking the said rod member in its position of maximum angle relative to said horizontal plane comprising a spring secured to said section and having a biased portion engaging the said rod and tending unless restrained to move the same from minimum angle to maximum angle position while said portion moves to a position blocking return movement of said rod.

11. A conical antenna including a boom and a pair of butterfly sections pivotally mounted on the forward end of the boom and each insulated from one another, and means bracing the sections from the boom, each section comprising a pair of segment shaped members having right angle walls along the edges thereof facing and interconnected to space said segment shaped members apart and provide thereby a segment-shaped pocket, each section being vertically arranged and having at least three outwardly extending rods with their inner ends secured therein, one rod comprising a central fixed horizontal rod, and the other two rods being pivotally mounted and movable between positions folded alongside the central rod to positions fanned away therefrom and substantially alongside the upper and lower radial edges of said pocket, and means locking the said two rods in fanned out positions.

12. A conical antenna including a boom and a pair of butterfly sections pivotally mounted on the forward end of the boom and each insulated from one another, and means bracing the sections from the boom, each section comprising a pair of segment shaped members having right angle walls along the edges thereof facing and interconnected to space said segment shaped members apart and provide thereby a segment-shaped pocket, each section being vertically arranged and having at least three outwardly extending rods with their inner ends secured therein, one rod comprising a central fixed horizontal rod, and the other two rods being pivotally mounted and movable between positions folded alongside the central rod to positions fanned away therefrom and substantially alongside the upper and lower radial edges of said pocket, and means locking the said two rods in

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fanned out positions comprising a leaf spring faced against the interior of one of the segment shaped members and having angled bends at opposite ends thereof, slots in the said one of the segment shaped members and said bends extending outward through the slots when the said rods are in folded position, but each biased to substantially retract into the pocket when the respective pivoted rod member is moved to fanned out position and block return movement of said rod member.

13. A structure as claimed in claim 12 in which the 10

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angled bends have means on the exterior of the pocket limiting retractive movement.

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