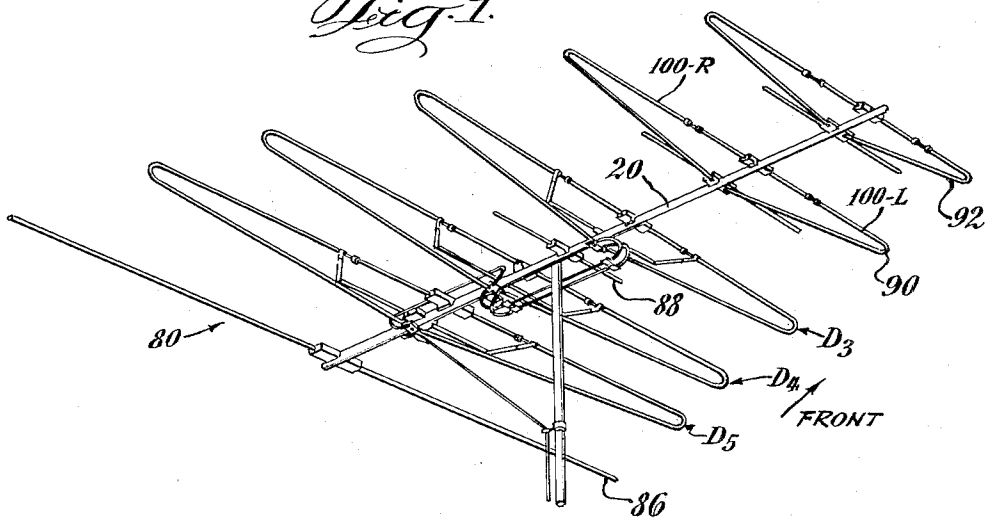
Nov. 27, 1956 J. F. GUERNSEY ET AL 2,772,413

COMPOSITE DIPOLE MULTI-CHANNEL TELEVISION ANTENNA

Filed March 30, 1956 5 Sheets-Sheet 1

Fig. 1.



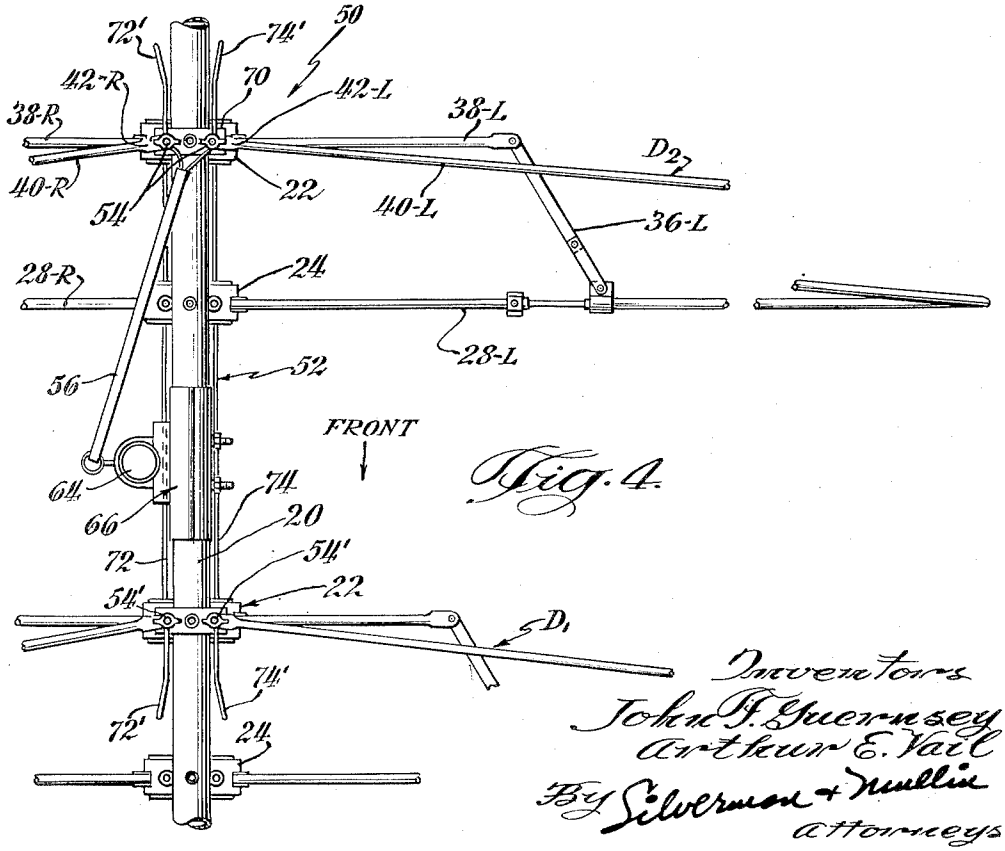


Fig. 4.

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COMPOSITE DIPOLE MULTI-CHANNEL TELEVISION ANTENNA

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Fig. 3.

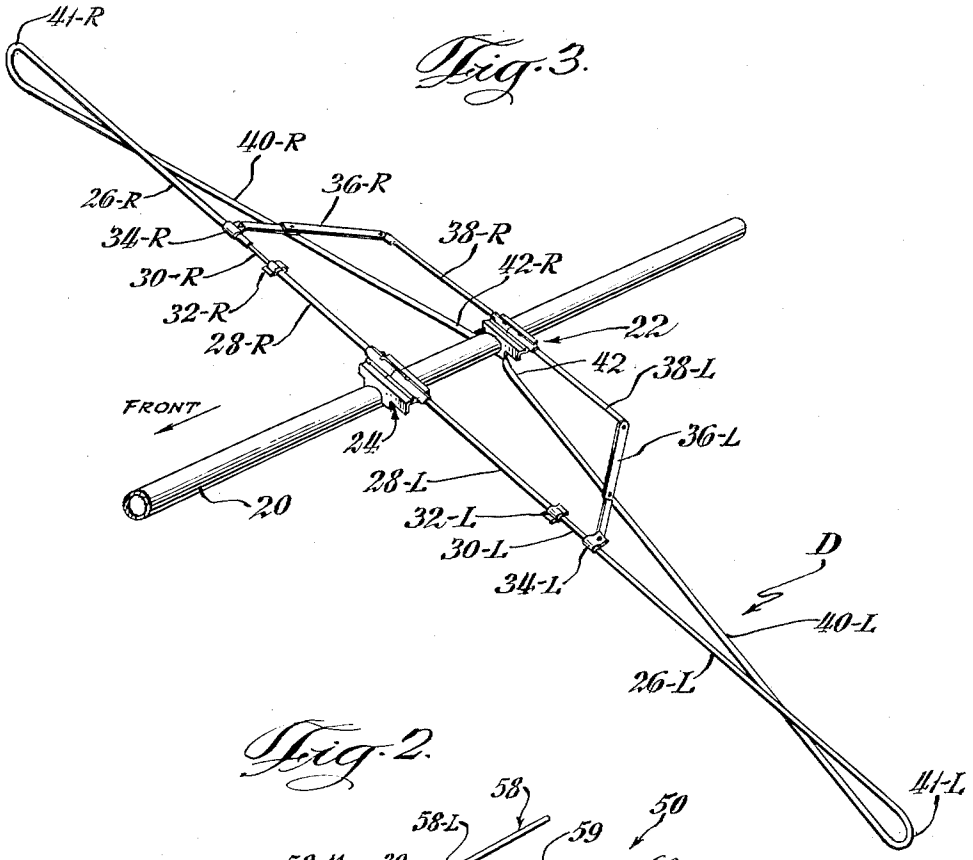
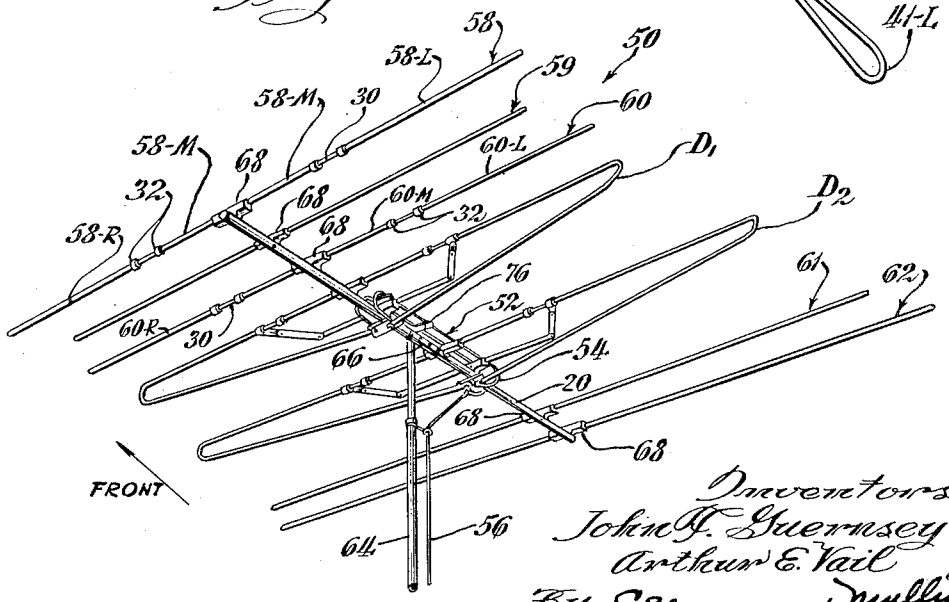


Fig. 2.



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COMPOSITE DIPOLE MULTI-CHANNEL TELEVISION ANTENNA

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Fig. 5.

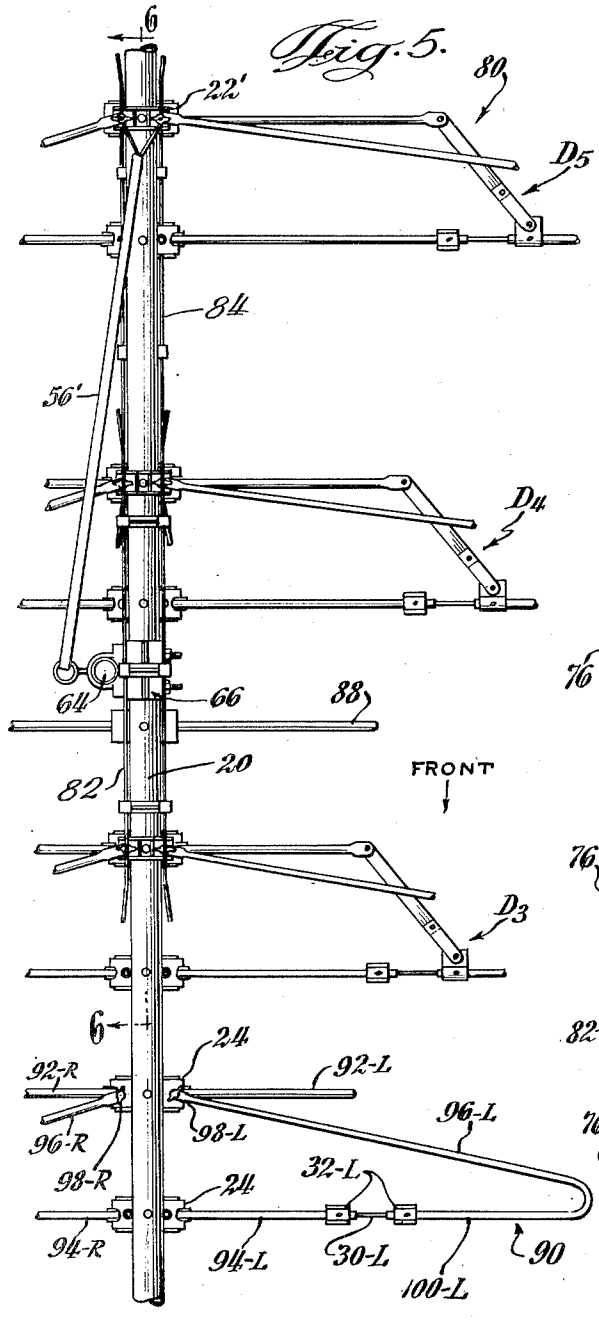
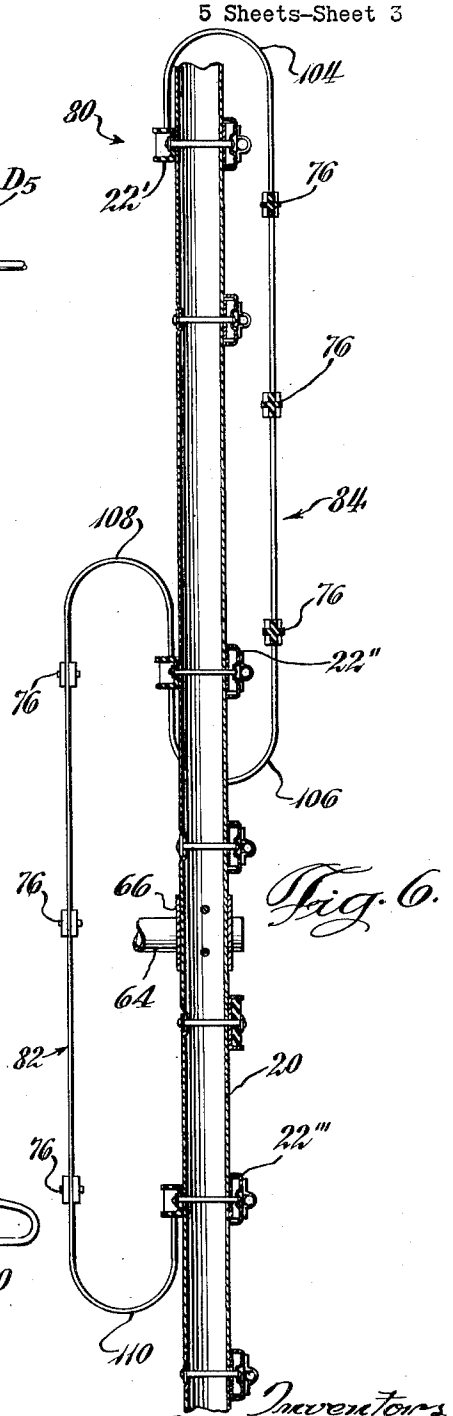


Fig. 6.



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COMPOSITE DIPOLE MULTI-CHANNEL TELEVISION ANTENNA

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Fig. 7.

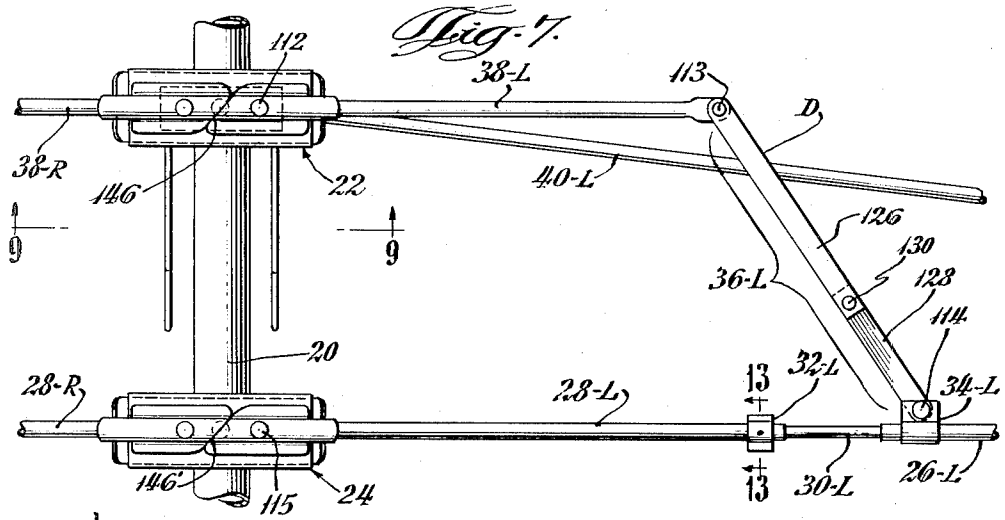


Fig. 7a.

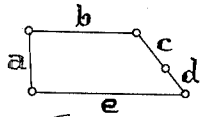


Fig. 8.

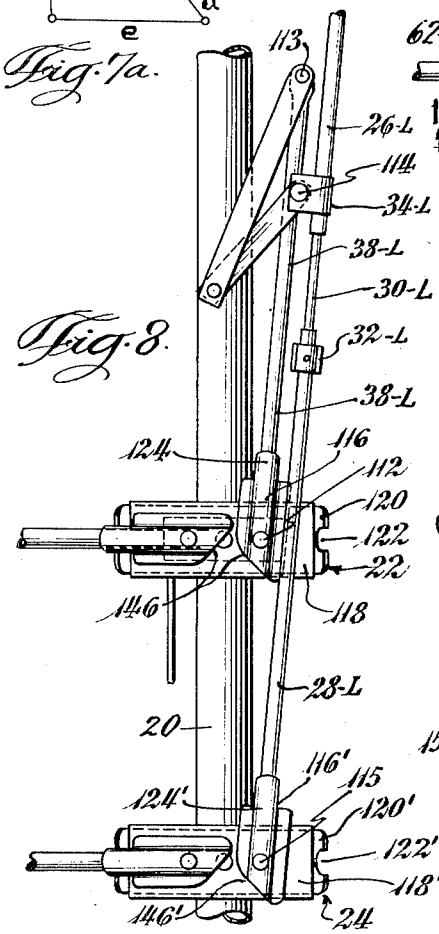


Fig. 10.

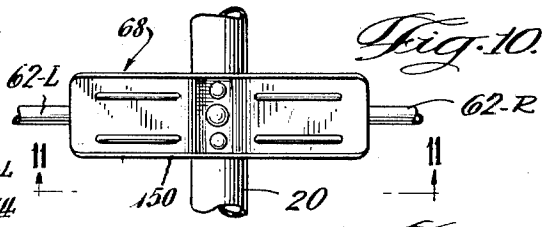


Fig. 9.

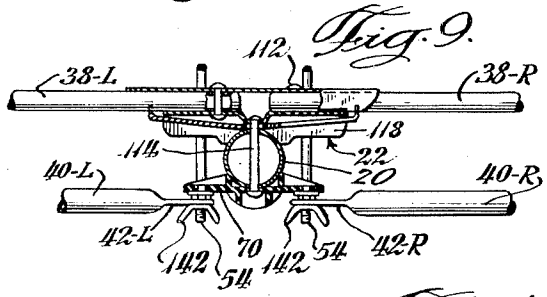


Fig. 11.

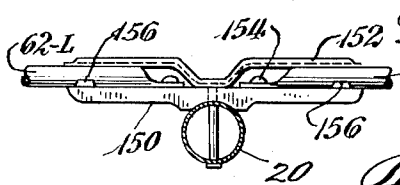


Fig. 12.

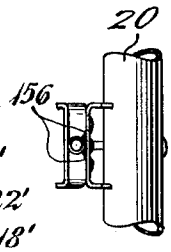


Fig. 13.



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COMPOSITE DIPOLE MULTI-CHANNEL TELEVISION ANTENNA

Filed March 30, 1956 5 Sheets-Sheet 5

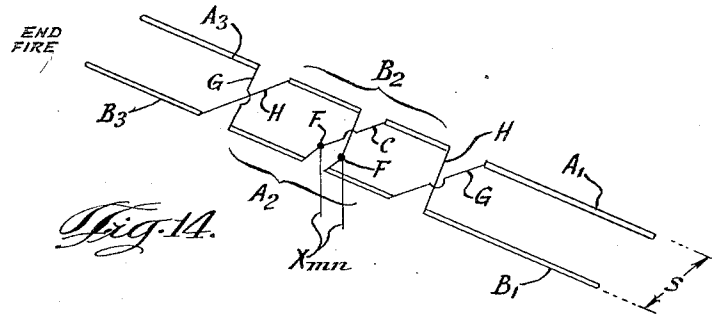


Fig. 14.

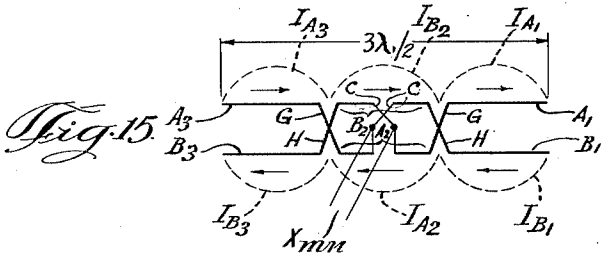


Fig. 15.

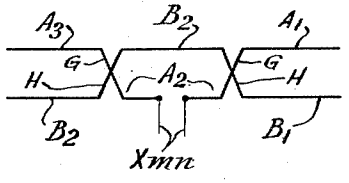


Fig. 16.

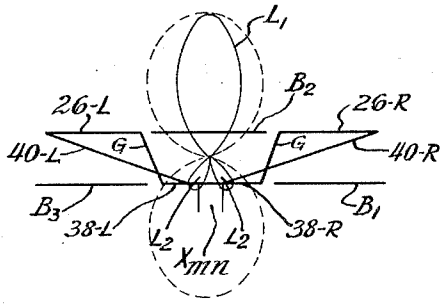
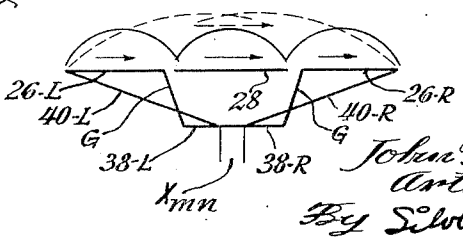


Fig. 17.

Fig. 18.



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United States Patent Office 2,772,413 Patented Nov. 27, 1956

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COMPOSITE DIPOLE MULTI-CHANNEL TELEVISION ANTENNA

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Application March 30, 1956, Serial No. 575,153

18 Claims. (Cl. 343—801)

This invention relates generally to high frequency antennas, and more particularly is concerned with the construction of an antenna whose specific, although not exclusive purpose, is the reception of television signals over the presently known television spectrum in the so-called low and high channels, as opposed to the ultra-high frequency channels. The presently utilized channels of television signal transmission are in two bands designated "low" consisting of channels 2 to 6 inclusive and "high" consisting of channels 7 to 13 inclusive. The range of frequencies for the low band are 54 to 88 megacycles per second and for the high band are 174 to 216 megacycles per second.

Although the description and discussion which follows hereinafter are specifically directed to the construction and operation of an antenna for the reception of television signals of the particular bands now available, it is not intended that the invention will be limited thereby. The antenna is operative with identical advantages in transmission as well as in reception and on other parts of the radio wave spectrum, for example by amateurs and for commercial and experimental use. Practically, of course, the transmission of television signals is accomplished by omni-directional single frequency antennas, and commercial transmission is usually accomplished on much less than twelve different frequencies from the same antenna.

A television antenna intended for reception of all signals available in a given location is required to receive transmitted signals in both of the available bands. In rural or fringe areas, the strength of signal requires antennas to have higher gain than in metropolitan areas where the signal strength of the transmitting stations is high. Broad band reception is required, and in the design and construction of television antennas many compromises must be made to meet the requirements of the user. Broad band reception usually goes hand in hand with low gain. High gain antennas are usually highly directive. An antenna which is efficient in the low band will usually be inefficient in the high band, and vice versa. Antennas with good reception qualities may have bad impedance characteristics so that the transfer of the signal to the receiver is inefficient.

Many problems are posed, as indicated by the statements made above, which do not completely set forth the difficulties which must be overcome in order to arrive at a structure which will provide high gain over the entire spectrum.

The construction of a high gain television antenna is further complicated by additional difficulties which might be summarized by listing what is needed in order to give the purchasing public maximum of benefit with minimum of cost:

1. First, of course, the antenna must be universal, i. e., provide substantially uniform high gain over the entire spectrum so that any purchaser in any area of the country may obtain good reception without the need for adjustment of the antenna other than at the time of

installation, and then only as to direction. Good color reception requires uniform gain also.

2. The antenna must occupy small volume and be made up of light weight elements so as not to be difficult to install, transport, and so that mounting is no problem due to weight.

3. The antenna must present as little resistance as possible to the wind and weather so that it may be expected to remain properly oriented if permanently affixed, or it may be expected not to place strain upon the mounting if rotatively affixed—and in any event so that it will not be blown down.

4. The antenna should be constructed in such a manner as to be foldable to admit of easy packaging, and be capable of assembly quickly and with a minimum of tools, if any.

5. The antenna must be capable of fabrication in production line methods to enable economy to be passed on to the purchasing public.

The principal object of this invention is to provide a high frequency antenna for the reception of signals over a wide spectrum with high gain and with the advantages enumerated above, many of them achieved because of the inherent structure of the antenna and others achieved because the construction permits of the same.

Still another object of the invention is to provide a novel composite dipole structure of the so-called end-fire type which has high gain and broad band characteristics not heretofore believed possible of achievement with an antenna of this type.

Another object of the invention is the provision of an array of composite modified end-fire dipoles so arranged in a single plane as to result in high gain over all the television channels between 2 and 13.

Still a further object of the invention is the provision of an antenna which includes, in addition to the composite dipole array, a novel arrangement of parasitic elements, increasing the gain and the rejection of back-received signals.

An important object of the invention lies in the provision of novel structure of the composite dipole elements of the antenna to enable them readily to be folded for transportation and storage.

Many other objects of the invention will become apparent as a description thereof proceeds, in connection with which preferred embodiments have been illustrated in drawings accompanying this specification, in order to make known the manner of construction and use of the invention.

In connection with the description, the nature of the theory of operation of the antenna of the invention will be alluded to, but this is only by way of a desire to assist in the understanding thereof and not by way of limitation. Whether the theory of operation is correct is immaterial, it being of prime importance that the structure described, illustrated and claimed performs the functions desired with outstanding and greatly improved results.

In the drawings, in which the same characters are used throughout the several figures to designate the same or similar parts:

Fig. 1 is a bottom perspective view of an antenna array for use on the television channels, composed of three driven composite dipoles constructed according to the invention and phased together to give maximum beneficial signal, the remaining elements of the antenna array being parasitics.

Fig. 2 is a similar view of an antenna array also for television use, in which there are only two driven composite dipole elements, the remaining elements being parasitics.

Fig. 3 is a perspective view of a single active com-

posite dipole element, constructed in accordance with the invention.

Fig. 4 is an enlarged bottom plan view of a portion of the antenna of Fig. 2 showing the manner of connecting the phasing harness and the transmission line to the receiver.

Fig. 5 is a view similar to that of Fig. 4 but of the antenna of Fig. 1.

Fig. 6 is a sectional view through the antenna of Fig. 1 taken along the line **6—6** of Fig. 5 and in the indicated direction.

Fig. 7 is a fragmentary top plan view of one of the composite dipoles of the invention showing the details of construction which enable the composite dipole to be folded substantially parallel with the boom.

Fig. 7*a* is a diagram used in explaining the folding of the composite dipole of Fig. 7.

Fig. 8 is a view similar to that of Fig. 7 but showing the composite dipole in folded condition.

Figs. 9, 10, 11, 12 and 13 are views showing the details of mechanical construction of the antenna of the invention, Fig. 9 being a sectional view through the composite dipole mounting of Fig. 7 on line **9—9**, Fig. 10 being a top plan view of a parasitic element mounting and Figs. 11 and 12, sectional views therethrough, and Fig. 13 is a section through a clamp (Fig. 7).

Figs. 14, 15, 16, 17 and 18 are diagrammatic views used for explanatory purposes in describing the theory of operation and showing how the construction of the composite dipole of the invention is derived.

Referring first to Fig. 3 there is illustrated an antenna which has herein been termed a composite dipole and which will be designated by the character D. The composite dipole D is mounted on the boom **20**, which in eventual disposition is arranged horizontally, by means of two brackets designated generally **22** and **24**. Details of the brackets will be reserved for another portion of this specification. The "front" of the composite dipole D, that is the direction of maximum signal gain is indicated by the arrow parallel with the boom **20**.

The front part of the composite dipole D is formed of three elements, the outboard elements **26** and the inboard element **28**. Following the chosen designation of direction, the inboard element **28** being formed of two halves meeting at the bracket **24**, these halves are designated **28**–R and **28**–L, for right and left (looking from rear to front of the composite dipole D). Likewise the outer elements are designated **26**–R and **26**–L. Each element **26** and **28** has substantially the same electrical length, but it will be noted that the elements are connected by insulating members **30**–R and **30**–L electrically separating the elements. For this purpose clamps **32**–R, **32**–L, **34**–R and **34**–L are provided. In the practical example **28** is a few percent longer than **26**–R or **26**–L which are equal, for a reason which will appear.

The clamps **34**–R and **34**–L each pivotally mount a rearwardly and inwardly extending link or connector designated respectively **36**–R and **36**–L which electrically connect the outboard elements **26** with the ends of a fourth element **38**. The element **38** has right and left halves **38**–R and **38**–L which meet at the bracket **22**, spaced rearwardly along the boom **20** from bracket **24**. The electrical length of element **38** is substantially the same as the electrical length of elements **26**–R and **26**–L. Thus, if the elements **26**–R, **26**–L and **38** each consist of a dipole resonant for a frequency f_3, then together the connected dipoles form a single dipole resonant for a frequency f_1 which is one-third the frequency f_3.

In the present-day frequency spectrum, the centers of the two bands have an approximate one to three frequency relationship, and hence the convenience of using such a composite dipole element as D for the two bands is apparent.

The composite dipole D has elongate diagonal elements **40**–R and **40**–L connecting the extreme outer ends of the outboard elements **26**–R and **26**–L respectively with the bracket **22**. This is a mechanical connection insofar as bracket **22** is concerned since the ends of diagonal elements **40**–R and **40**–L form terminals for driving the composite dipole D and hence are insulated from the boom **20**. By "driving" it is meant that the antenna is connected with a transmission line, for connection either to a transmitter or a receiver. Obviously, where the antenna is a television receiving antenna, the composite dipole D will be connected with a television receiver.

The construction of brackets **22** and **24** will be described hereinafter in connection with Figs. 7, 8, 9. Suffice it to say at this time that the bottom of bracket **22** has an insulator block thereon, and the ends of the diagonal elements **40**–R and **40**–L are connected to the block, from whence either transmission line or phasing harness terminals, or both, may be connected.

The diagonal elements **40**–R and **40**–L are integral continuations of the outboard elements **26**–R and **26**–L respectively, being joined thereto by means of the bends **41**–R and **41**–L respectively. It will be noted that the free ends which are designated **42**–R and **42**–L extend from a level on the topside of the boom **20** to a level below the boom and spaced rearwardly of the bends **41**–R and **41**–L so that the elements of the composite dipole D are not actually co-planar. The diagonal elements are somewhat twisted downward and backward. It is desired to point out, however, that this is a matter of practical construction and not an electrical requirement of the dipole. The elements of the dipole could satisfactorily and desirably be in substantially a horizontal plane.

The described construction of a single composite dipole D illustrates that the antenna is disposed anything but broadside to the wind, so that the principal stress from wind is reduced over other antennas of collinear type which have a plurality of elements in vertical planes.

The function of the diagonal members **40**–R and **40**–L is not only to provide support for the antenna, but as well to increase the terminal impedance for a better match to the usual transmission lines of approximately 300 ohms terminal impedance. Thus, the composite dipole D may be considered a folded dipole structure.

The composite dipole element D may be termed a modified, end-fire, folded, unidirectional element for reasons presently to be pointed out. For the discussion which follows, attention is invited to Figs. 14, 15, 16, 17 and 18 in connection with which an attempt will be made to explain a likely theory of operation of the antenna.

Figs. 14 and 15 represent the known form of end-fire antenna. Considering a pair of parallel collinear arrays of

$$\frac{3\lambda}{2}$$

length, made up of three simple dipoles each comprising A_1, A_2, A_3 and B_1, B_2, B_3, if the center dipoles of the arrays are interposed and each array fed from a common transmission line, the arrays will be in phase. Current distribution will be as indicated by the broken line diagrams I_{A_1}, I_{A_2}, I_{A_3}, I_{B_1}, I_{B_2}, I_{B_3}. The instantaneous direction is as indicated by the arrows in Fig. 15.

The transposition of center dipole A_2 and B_2 is accomplished by cross-connecting links G and H. The phase of the collinear arrays is reversed by a transposition of the terminals of the center elements through the medium of a connecting cross-over harness C, and the correct phase relationship of antenna arrays one to the other depends on the spacing S. The transmission line *Xmn* is thus connected at a point F—F which takes this into account.

It will be recalled that the phase of a given wave front will necessarily change from the time that it is intersected by the front collinear array until the time that it reaches the second collinear array, and the amount of change is a function of the frequency and the distance S, or in other words, the distance in wave length from

the front to rear collinear arrays. This demonstrates the need for the adjusted connection of the transmission line. Close spacing of the arrays gives best gain. (The spacing of the practical example D is approximately

$$\frac{\lambda_1}{10} \text{ to } \frac{\lambda_1}{8}$$

where λ_1 is the frequency at which any of the elements 26 or 28 is a dipole.)

The characteristics of the end-fire antenna of Figs. 14 and 15 are not suitable for television reception because the radiation pattern, while fairly narrow, is the same front and back, and the antenna is suitable for use on only one frequency λ_1, or at best λ_1 and $3\lambda_1$, although phasing between arrays is not suitable on the latter frequency.

It was discovered that by de-coupling one array completely, and center feeding the other array, an unusual and not contemplated result was obtained. Instead of being bi-directional the dipole element became unidirectional, giving an excellent forward radiation lobe L_1 in the direction from which the de-coupled center section B_2 is the front of the antenna and small rear minor lobes L_2 off center. There being no direct coupling between arrays, there is no need for coupling harness CC, and the antenna may be fed at the center of the dipole A_2. Instead of being a single frequency antenna, the resulting structure had excellent broad characteristics over the entire spectrum of the television high-band and gave good results over the low-band. Impedance-wise the assemblage had a terminal impedance of the order of 300 ohms on the high band, but of considerably less on the low band. By adding the diagonal elements 40–R and 40–L the antenna appeared as a folded dipole on the low band and hence the terminal impedance for those frequencies was substantially increased to approximately 300 ohms without materially affecting the antenna characteristics on the high band frequencies.

Of importance and considerable additional improvement over the ordinary end-fire antenna is the lack of criticality of the dimensions of the driven elements A_1, A_2 and A_3 which are respectively the dipoles 26–R, 38–R and 38–L, and 26–L in the practical embodiment, diagrammed in Fig. 18. The diagram of Fig. 16 is an intermediate stage of the antenna between the end-fire antenna of Fig. 15 and the preferred example of Fig. 17. The difference lies in the elimination of the cross connecting members H whereby greater de-coupling of the elements B_1, B_2 and B_3 from the driven elements A_1, A_2 and A_3 is accomplished.

It will be appreciated that the elements B_1, B_2 and B_3 appear to be parasitics in that they are fully disconnected metallically from the driven elements and the transmission line *Xmn*. However, their spacing and interposition between elements A_1, A_2 and A_3 is such that there may be some nature of coupling not inconsistent with the usual understanding of the operation of parasitics. In choosing the dimensions of the elements B_1, B_2 and B_3 if the dimensions of the driven elements are chosen to be dipoles for the center of the high band, say channel 10, and the elements B_1, B_2 and B_3 are handled as parasitics, best results are obtained. B_1 and B_3 being to the rear of the elements A_1 and A_3 respectively are made reflectors for channel 7, the low end. B_2 being in front of element A_2 is made a director for channel 13, the high end. The final result was that all of the so-called parasitic elements B_1, B_2 and B_3 were somewhat longer than the respective elements A_1, A_2 and A_3.

The dipole D represents an economical variation of the preferred structure in which the elements B_1 and B_3 are eliminated. An antenna which uses these elements, properly supported and cut to the lengths described above, will give increased gain—up to 2 db on the high band frequencies. This gain must be weighed against the increased cost of mass producing such antennas.

In. Fig. 18, the resulting current distribution of the practical dipole D is shown, with the high band current represented by solid lines and the low band represented by broken lines. The arrows indicate instantaneous direction.

The antenna described may be used by itself, that is, benefits of the invention are achieved through the application of the composite basic dipole D for reception or transmission of high frequency signals. Obviously, pattern and gain are improved by stacking and multiple arrays. In utilizing the composite antenna element D, however, several combinations of composite dipoles with systems of parasitics have given excellent results for reception of television signals over all channels of high and low bands.

In Fig. 2 there is illustrated an antenna 50 which has two driven composite dipoles D_1 and D_2 of the identical construction as the composite dipole D, coupled together by a phasing harness 52 which is in turn connected at 54 to the transmission line 56. There are five parasitic elements which are designated from front to rear 58, 59, 60, 61 and 62. All elements are mounted on a horizontal boom 20 which is supported on a vertical mast 64 by means of a suitable clamp 66. All of the parasitic elements are supported at their centers by identical metallic brackets 68 and the supports for the dipoles D_1 and D_2 are brackets identical to 22 and 24 already mentioned. Details of brackets 68 will be given below in connection with Figs. 10, 11 and 12.

The elements 58 and 60 serve as directors for the high band frequencies. Each is formed of three short side-by-side elements 58–R, 58–M, 58–L and 60–R, 60–M, 60–L, respectively. The separation between short elements being effected by lengths of insulating material 30 identical with the lengths 30–R and 30–L of composite dipole D, held in place by clamps 32 substantially identical to clamps 32–R and 32–L of composite dipole D. As will be explained, the middle sections 58–M and 60–M, fold in two to permit collapse of the antenna.

Element 59 is operative as a director in the low band. It also folds in the center.

Elements 61 and 62 serve as low band reflectors and at least element 61 serves as a high band reflector.

The array described gives extremely high gain and directivity, over all channels of the television bands, using the basic characteristics of the composite dipoles D_1 and D_2 enhanced by Yagi principles. With proper choice of dimensions the two composite dipoles D_1 and D_2 not only give two-step broad coverage over the bands, but also complement one another as parasitic reflector or director as the case may be through proper spacing and phasing.

Reference now will be made to Fig. 4 which is a fragmentary bottom plan view of the antenna 50 showing the two driven composite dipoles D_1 and D_2 connected to be in proper phase so that both may feed the transmission line 56. The bracket 22 is of metal except for the bottom insulator member 70 and the inner ends of the members 38–L and 38–R being pivotally mounted on the bracket 22 by metal rivets, as will be described, establishes electrical connection between the boom 20 and the members 38–R and 38–L. Since the potential at the center of the dipole 38 is substantially zero, this is of no consequence. Likewise, the parasitic dipole 28 is mounted with the inner ends of the halves 28–R and 28–L metallically connected to the boom 20 through bracket 24.

The ends 42–R and 42–L of the diagonal members 40–R and 40–L respectively are flattened and connected to binding posts 54 provided on the insulator 70. The terminals of the transmission line 56 of the antenna 50 are also connected to these binding posts 54 of the com-

posite dipole D_2 toward the rear of the antenna. The composite dipole D_1 has identical construction enabling the mounting of the same, although its dimensions are somewhat smaller than composite dipole D_2 so that it covers a somewhat different range of frequencies, albeit overlapping. The binding posts 54' of its bracket 22 serve as terminals for the phasing harness 52, the other terminals of which are the binding posts 54.

The phasing harness is a pair of wires or metal conductors 72 and 74 which comprise a transmission line and are spaced from one another and from the boom, and extend parallel between the dipoles D_1 and D_2, for convenience being disposed on the top of the antenna above the boom 20. The ends of the wires 72 and 74 are bent in loops 72' and 74' which extend downward and around the brackets 22 and 24, clearing the brackets, parts of the dipoles and the boom to enable the connection to the binding posts 54 and 54'. The ends are preferably bent into eyes to provide good securement, and insulating spacers 76 may be provided along the length of the harness 52. The length of the harness is sufficient to adjust the phasing between composite dipoles D_1 and D_2 so that they will augment and complement one another on all frequencies. Thus, when not serving as a driven element, the dipole will be a parasitic for its mate.

Much better results, that is to say more uniform and higher gain over the high and low television bands is obtained with an antenna 80 illustrated in Figs. 1, 5 and 6. As in the case of previously described antennas this is a modification in which composite dipoles similar to D are used having elements which exclude B_1 and B_3 because of practical reasons.

The antenna 80 is mounted on a boom 20 and supported upon a vertical mast 64 by a clamp 66 of any suitable design. The driven elements of the antenna are three in number, and are designated D_3, D_4 and D_5 commencing with the foremost element. All are substantially identical in construction to the element D and are chosen to cover the entire spectrum of high and low bands of the television spectrum in three ranges instead of two. The frequencies for which the composite dipoles D_3, D_4 and D_5 are cut decrease from front to rear of the antenna, and phasing harnesses 82 and 84 are provided of substantially the same construction as the phasing harness 52, for connecting the three driven elements in proper phase.

The elements of the antenna include, in addition to the driven ones, an integral rear reflector 86, which serves the low band; an intermediate high band element 88 and two composite parasitic elements 90 and 92. These latter two antennas serve as directors on high and low bands. The foremost of these, namely 92, is the smaller. Otherwise, they are the same in construction. Considering element 90 (see Fig. 5) metallic brackets substantially identical to the brackets 24 are mounted on the boom 20, spaced apart a suitable distance, and properly arranged relative to the dipoles D_3, D_4 and D_5. A rear high band parasitic element 92 is mounted on the rear bracket and a front high band element 94 is mounted on the front bracket 24. The outer ends of the front high band element 94 are connected with diagonal elements 96 (designated 96–R and 96–L in association with the respective element halves 92–R—94–R and 92–L—94–L). The connection is achieved through insulating members 30–R and 30–L and clamps 32–R and 32–L.

There is a metallic connection between the elements 92, 94 and 96 and the boom, since all are parasitics. The ends of 96–R and 96–L may be secured to the rear bracket 24 by thumb nuts, for example, as at 98–R and 98–L, to aid in folding the composite assemblage 90.

On high frequencies, it is believed, the outboard portion 100–R and 100–L are of a phase cancelling the effect of the aligned outer portions of the slanted elements 96–R and 96–L thus providing in effect a high band parasitic element in addition to elements 92 and 94. On low frequencies, it is believed, the elements 92, 94 and the parts 100–R and 100–L have no effect upon the action of the slanted portions alone combining to form a veed forward parasitic element.

The intermediate element 88 acts either as a reflector for high band elements in the composite dipole D_3 or as a director for high band elements in composite dipoles D_4 and D_5 depending upon the frequency at which the antenna 80 is being operated.

The harnesses 84 and 82 are mounted as best shown in Fig. 6. The harness 84 with its intermediate spacers 76 is above the boom 20 (to the right as seen in Fig. 6) and its ends 104 and 106 curve around and down to be connected respectively to the binding posts of the brackets 22' and 22'' which are identical in construction to bracket 22. The harness 82 is disposed on the bottom of the antenna and its ends 108 and 110 respectively curve around and upward and are secured respectively to the binding posts of the brackets 22'' and 22'''. Each of the brackets 22', 22'' and 22''' has the same insulator 70 referred to, and the binding posts are identical with binding posts 54 to conductively tie the diagonal elements 40 of the dipoles in parallel, properly phased and fed by the transmission line 56' which is also connected to the rear bracket 22'.

It is not believed necessary to describe the remaining details of the antenna 80, since in all other respects its parts are identical with parts already described.

Considering Figs. 7, 8, 9, 10 and 11 the structure which enables the antenna to be folded for shipment in narrow cartons, and which enables easy erection is illustrated. This structure is common to all of the composite dipoles D, D_1, D_2, D_3, D_4 and D_5. The half of the composite dipole D which includes the elements 38–L, 28–L, and 36–L is a trapezoid. For ease in assembly without tools, the four corners of the trapezoid (as do all others) are permanently secured by pivotal rivets or pins 112, 113, 114 and 115. The pin 112 passes through the protective end cap 116 and flattened end of the element 38–L and is secured to the base 118 of the bracket 22. An upwardly biased leaf spring 120 having a seating slot 122 is adapted to ride the outer formed channel 124 of the cap 116 to snap the element 38–L into position normal to the boom 20 when moved from the folded position of Fig. 8 to the extended position of Fig. 7. The spring 120 must be forced away from the cap 118 to permit folding, if desired, but this is somewhat difficult, since the extended condition of the elements is intended to be permanent.

The element 28–L is secured to the bracket 24 by rivet or pin 115 in the same manner. There is a cap 116', a base 118', a spring 120', a slot 122', a channel 124' all of which function the same as the elements similarly designated but unprimed.

The connecting link 36–L is formed of two parts 126 and 128 permanently pivoted at 130 intermediate the ends which connect between link 38–L and 26–L. In order that the trapezoidal formation be foldable so that the entire element D is capable of being disposed substantially parallel with and alongside the boom 20, the various lengths of the elements must be properly proportioned. This is done by choosing the position of the pivot 30 so that the distance from pivot 115 to pivot 114, plus the distance from pivot 114 to pivot 130 is equal to the sum of the distance from pivot 115 to pivot 112 plus the distance from pivot 112 to pivot 113 plus the distance from pivot 113 to pivot 130. In other words, as indicated by diagram of Fig. 7a, $a+b+c=d+e$. When this condition is met, at least substantially, the folding of the element D can be accomplished. The diagonal elements 40–R and 40–L have their ends 42–R and 42–L perforated, and these ends must be disconnected from the binding posts 54 to permit folding but are reconnected when the composite dipole is extended.

It will be noted that the bracket **22** has the metallic base **118** mounted to the boom **20** by a long bolt or rivet **114** which secures the insulator **70** on the bottom, but electrically independent of the base **118** so that the binding posts **54** connect metallically only with the elements **40**–R and **40**–L and such harnesses and transmission lines as may be secured thereto by the thumb nuts **142**.

The facing caps **116** and **116'** of the brackets **22** and **24** have cooperative diagonal facing ends **146** and **146'** which engage to provide a locking engagement providing alignment of oppositely extending elements. Obviously one side must be folded or extended before the other.

Bracket **68** comprises a metal base **150** riveted to the boom **20** and having a resilient cover plate **152**. The elements such as, for example, **62**–R and **62**–L are pivoted to the base at **154** and the base has upwardly struck inwardly extending lugs **156** forming pockets with slanted sides into which the elements **62**–R and **62**–L are readily snapped but out of which the elements cannot be rotated without substantially distorting the parts. Obviously other brackets permitting folding of the parasitic elements can be used.

Fig. 13 illustrates the clamp **32** which is a tubular member crimped around the ends of metallic elements with insulating rod in the center. Any crimping or clamping means can be used.

In order to provide sufficient information to enable one skilled in the art to construct the antennas of the invention, the practical embodiments for use in receiving television signals on the present channels have been set forth hereinafter for the antenna **80**. Adaptation for the antenna **50** is readily capable of being accomplished.

D_3

Composite dipole D_3 is resonant at channel 6 and channel 13.

	Inches
Length of **28** end to end	23.5
Length of **38** end to end	21
Length of **40**–L (or **40**–R)	32.75
Length of **26**–L (or **26**–R)	19.25
Length of **30**–L (or **30**–R)	2
Front to rear width (S)	6.5

D_4

Composite dipole D_4 is resonant at channel 4 and channel 10.

	Inches
Length of **28** end to end	26
Length of **38** end to end	25.5
Length of **40**–L (or **40**–R)	40.5
Length of **26**–L (or **26**–R)	25.75
Length of **30**–L (or **30**–R)	2
Front to rear width (S)	6.5

D_5

Composite dipole D_5 is resonant at channel 2 and channel 7.

	Inches
Length of **28** end to end	31
Length of **38** end to end	30
Length of **40**–L (or **40**–R)	48.5
Length of **26**–L (or **26**–R)	31.25
Length of **30**–L (or **30**–R)	2
Front to rear width (S)	6.5
Overall length of harnesses:	
82	38
84	38
Distance between D_3 and D_4	19.5
Distance between D_4 and D_5	19.5
Distance between D and **90**	9.75
Distance between **90** and **92**	16.5

Parasitic 90

	Inches
Length of **94** end to end	24.5
Length of **92** end to end	24.5
Length of **100**–L (or **100**–R)	10.5
Length of **96**–L (or **96**–R)	25
Length of **30**–L (or **30**–R)	1

Parasitic 92

This element may either be the same size as element **92** or proportionally smaller, as for example, to resonate at slightly higher frequencies.

	Inches
Overall length of parasitic **88**	26
Overall length of parasitic **86**	110
Distance from D_5 to **86**	32.5
Distance from D_4 to **88**	6.5

It is believed that the invention has been sufficiently described to enable one skilled in the art to understand, use and construct the same. The dimensions given have not included the lengths of the elements **36** and their parts, but these are easily computed from the specification. The antenna resulting from the invention is an array which to all intents and purposes is disposed in a horizontal plane and hence presents very little resistance to wind and produces very little moment upon the mast **64**. The gain of the antenna over the entire spectrum is quite high and uniform. On channels 2 to 6 the directivity of the antenna is quite high, there being a front to back ratio of between 15 and 26 db, with no side lobes. On the high channels there are very minor side lobes, but the front to back ratio is still quite high. Considerable variation in these dimensions is well within the purview of the invention, and indeed such variations are made from time to time in the practical production of the antennas. For example, the distances between D_3 and **90**, and **90** and **92** may both be approximately 13 inches. Optimum dimensions may also vary from location to location, but importantly, a great deal of criticality inherent in high gain antennas has been eliminated by the structure of the invention.

Parasitic configurations of other types may be used.

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

1. A composite antenna for high frequency signals comprising a plurality of dipole elements all arranged in substantially a horizontal plane, there being three collinear dipole elements and the antenna being highly directive along an axis normal to the collinear dipole elements, a fourth dipole element centered on the said axis spaced from and parallel with the middle one of the three collinear dipole elements, the four dipole elements being substantially of the same electrical length, the said middle dipole element being a director parasitic relative said fourth dipole element and the two outboard collinear dipole elements having their inner ends electrically connected to the ends of the fourth dipole, and transmission line means connected to drive the two outboard collinear dipole elements and the fourth dipole element.

2. A composite antenna as claimed in claim 1 in which there are two additional dipole elements collinear with said fourth dipole element but arranged outboard thereof and each a reflector parasitic relative the respective first mentioned outboard collinear dipole elements.

3. A composite antenna as claimed in claim 1 in which there is a fifth dipole element, but having an electrical length substantially three times the electrical length of said four dipole elements, said fifth dipole element being slightly veed with its outer ends connected to the outer ends of the outboard collinear dipole elements and its center disposed substantially at the center of the fourth dipole element, said center of the fifth dipole element being connected with said transmission line means.

4. A composite antenna as claimed in claim 1 in which

the spacing between the first mentioned three collinear dipole elements and the fourth dipole element is approximately one-fourth the electrical length of the dipole elements.

5. A composite antenna as claimed in claim 3 in which the spacing between the first mentioned three collinear dipole elements and the fourth dipole element is approximately one-fourth the electrical length of the dipole elements.

6. A composite antenna for high frequency signals adapted for high directivity unilaterally, comprising a metallic horizontal boom coaxial with the direction of directivity, a first dipole element normal to the boom and in a horizontal plane and metallically connected at its center with the boom, second and third dipole elements of substantially the same electrical length as the first dipole element arranged outboard thereof and collinear therewith and slightly spaced from the outer ends of the said first dipole element, insulating means mechanically connected between each of the outboard elements and said first dipole element, a fourth dipole element parallel with the first dipole element in the same horizontal plane and spaced axially therefrom on the boom, having its center metallically connected to the boom, a metallic link between each of the outer ends of said fourth dipole element and the inner ends of the outboard dipole elements, and a pair of conducting members extending respectively from the outer ends of the outboard dipole elements to the boom at a point spaced axially along the boom from the said first dipole element, means insulatedly securing the pair of conducting members to the boom and insulated from one another, and transmission line means connected to the pair of conducting members.

7. A composite antenna as claimed in claim 6 in which the axial point at which the pair of conducting members is connected to the boom is substantially the same as the point at which the said fourth dipole element is connected to the boom but on the opposite side therefrom.

8. A composite antenna as claimed in claim 6 in which the said first dipole element is formed of a length to render same a parasitic element relative the said fourth dipole element.

9. A composite antenna as claimed in claim 6 in which the first and fourth dipole elements are each formed of halves and the halves are each pivotally mounted to the boom for swinging movement in a horizontal plane, the conducting members are adapted to be removably secured to the boom at said point, and the said metallic links are pivotally secured at their ends and foldable between said ends, whereby the entire antenna may be collapsed with all of the elements and the conducting members arranged generally parallel with and alongside the said boom.

10. A composite antenna as claimed in claim 6 in which the area subtended on each side of the boom by the boom, half of said first dipole element, an insulating means, a metallic link, and half of said fourth dipole element is trapezoidal in configuration, with the link forming the diagonal side of the trapezoid.

11. A composite antenna as claimed in claim 9 in which the area subtended on each side of the boom by the boom, half of said first dipole element, an insulating means, a metallic link and half of said fourth dipole element is trapezoidal in configuration, with the link forming the diagonal side of the configuration, the link being foldable at a pivot point such that the sum of distance measured between pivots of the first and fourth dipole half elements on the boom plus the distance between the pivots of the fourth dipole half, plus the distance along the link between the pivot with the fourth dipole element and the folding pivot point, equals the sum of the remainder distance along the link, plus the distance measured between the pivot point of the link and the outboard dipole element to the pivot of the first dipole half element with the boom.

12. A composite antenna as claimed in claim 6 in which each conducting member is integral with an outboard dipole element and there is an arcuate reverse bend connecting each conducting member with the end of one of the outboard dipole elements whereby the two contive along an axis normal to the collinear dipole elements, length of which is substantially three times the electrical length of the said four dipoles.

13. An antenna array which is formed of at least a pair of composite dipole assemblages, each assemblage being arranged in substantially the same horizontal plane spaced one from the other and parallel one relative the other, a common horizontally arranged boom having the dipole assemblages mounted thereon, means supporting the boom, and transmission line means driving the assemblages, each assemblage comprising a first dipole element mounted at its center on the boom and having second and third collinear dipole elements respectively insulatedly connected at the ends of the said first dipole element and mechanically supported therefrom, a fourth dipole element spaced from the first dipole element, parallel therewith and secured to the boom also at its center, a metallic link between each of the ends of the fourth dipole element and the respective inner ends of the said outboard dipole elements, a pair of rigid conductor elements having inner and outer ends, the outer ends being respectively connected with the outer ends of said outboard dipole elements, and the inner ends being insulatedly secured to said boom at the center of the said fourth dipole element, and said transmission line means being connected to said inner ends.

14. An antenna array as claimed in claim 13 in which said transmission line means include a phasing harness between the inner ends of the rigid conductors of each of said dipole assemblages having a length for phasing the said assemblages additively.

15. An antenna array as claimed in claim 14 in which the physical dimensions of one assemblage are proportionally smaller than the physical dimensions of the other assemblage and the smaller assemblage is located forward of the other considering the maximum directivity of the array.

16. An antenna as claimed in claim 15 in which both assemblages are foldable to positions substantially parallel with the boom.

17. A composite antenna for high frequency signals comprising a plurality of dipole elements all arranged in substantially a horizonal plane, there being three collinear dipole elements and the antenna being highly directive along an axis normal to the collinear dipole elements, a fourth dipole element centered on the said axis spaced from and parallel with the middle one of the three collinear dipole elements, the four dipole elements being substantially of the same electrical length, the said middle dipole element being a director parasitic relative said fourth dipole element and the two outboard collinear dipole elements having their inner ends electrically connected to the ends of the fourth dipole.

18. A composite antenna for high frequency signals comprising a plurality of dipole elements arranged in substantially a horizontal plane, there being three collinear dipole elements and the antenna being directive along an axis normal to the collinear dipole elements, a fourth dipole element centered on the said axis spaced from and parallel with the middle one of the three collinear dipole elements, the four dipole elements being substantially of the same electrical length, the said middle dipole element being of length rendering same parasitic relative to said fourth dipole element and the two outboard collinear elements being coupled at their inner ends to the respective ends of said fourth dipole, said two outboard collinear dipole elements and fourth adapted to be connected to electrical energy transmission means.

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