

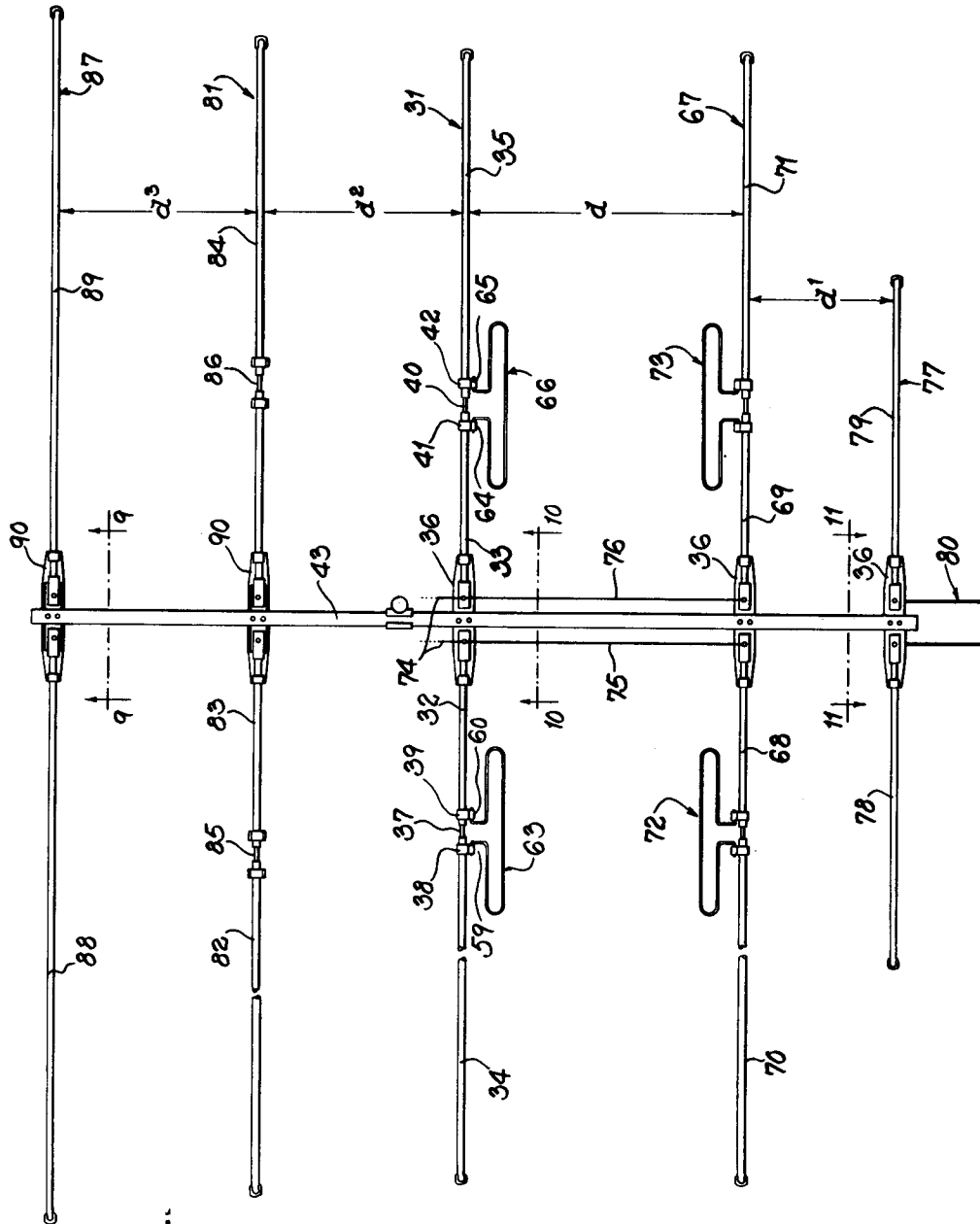
Filed Feb. 12, 1954

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2,705,283

SHARPLY DIRECTIONAL WIDE BAND ANTENNA

5 Sheets-Sheet 1



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March 29, 1955

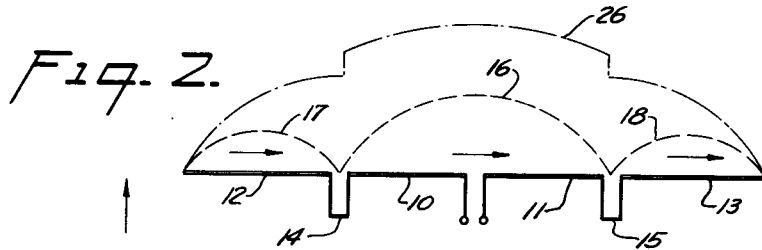
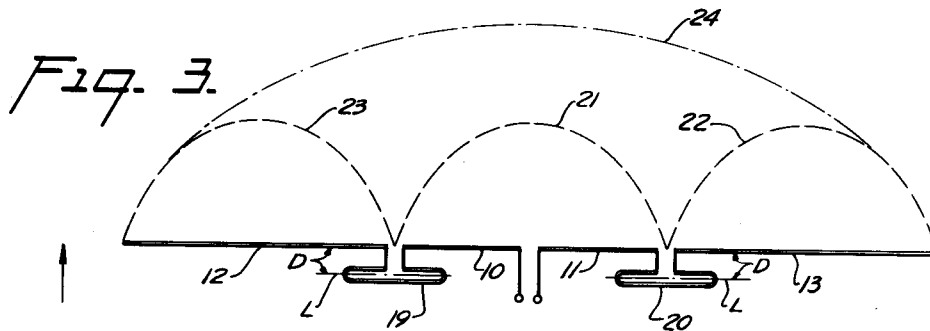
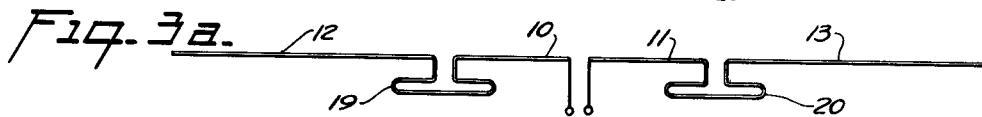
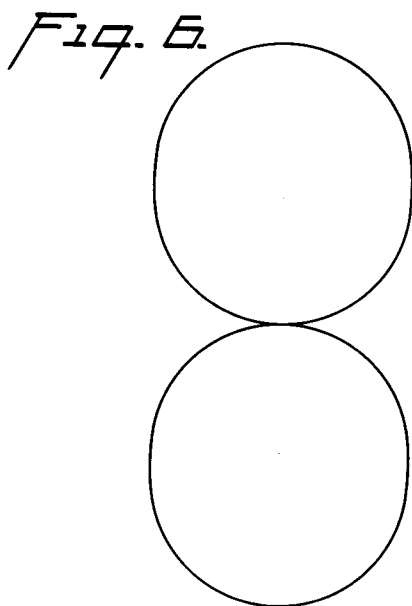
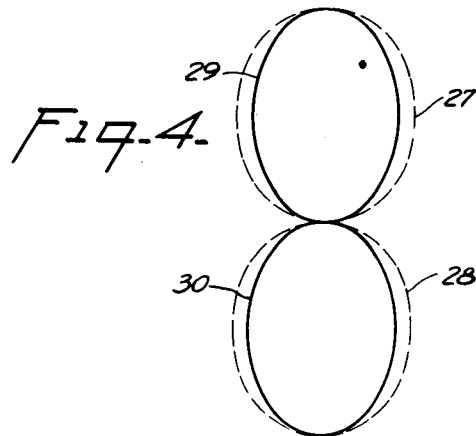
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SHARPLY DIRECTIONAL WIDE BAND ANTENNA

Filed Feb. 12, 1954

5 Sheets-Sheet 2



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SHARPLY DIRECTIONAL WIDE BAND ANTENNA

Filed Feb. 12, 1954

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Fig. 5.

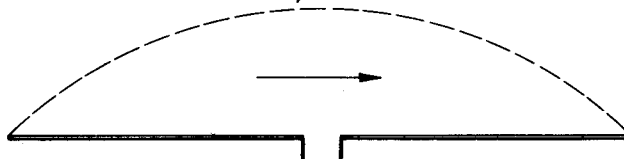


Fig. 7.

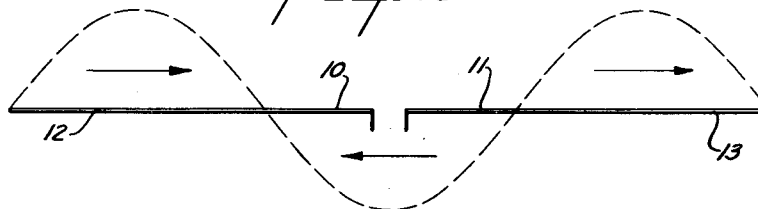
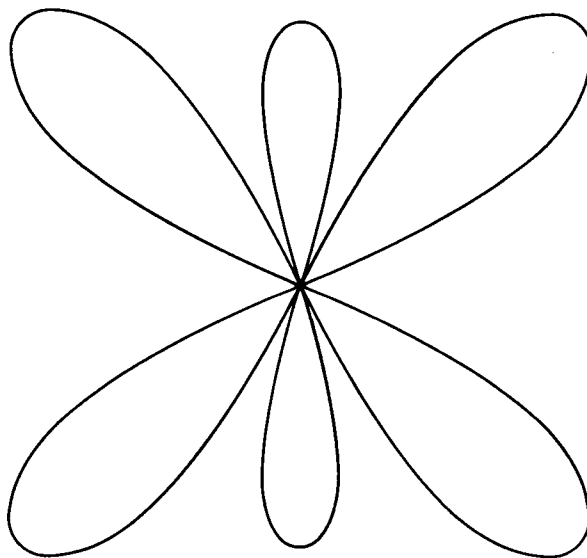


Fig. 8.



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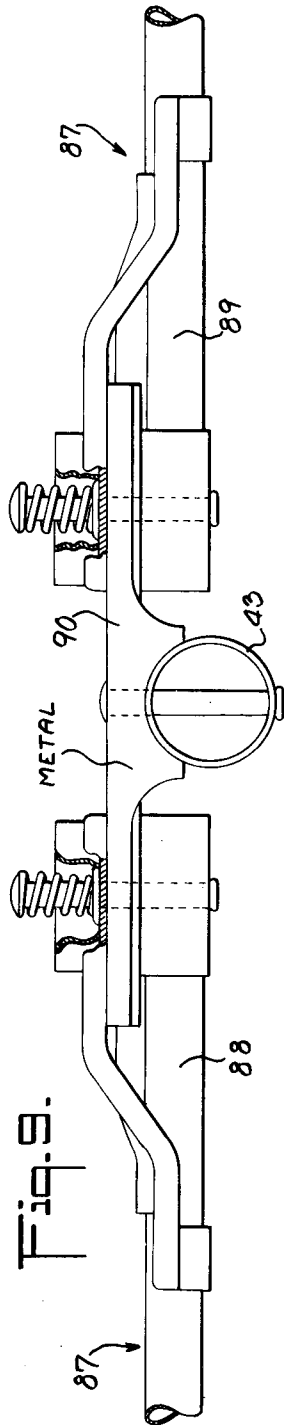
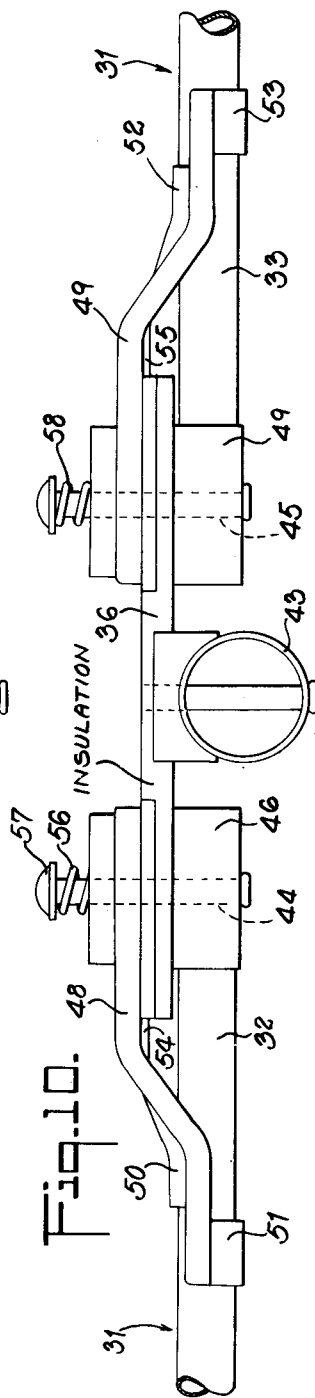
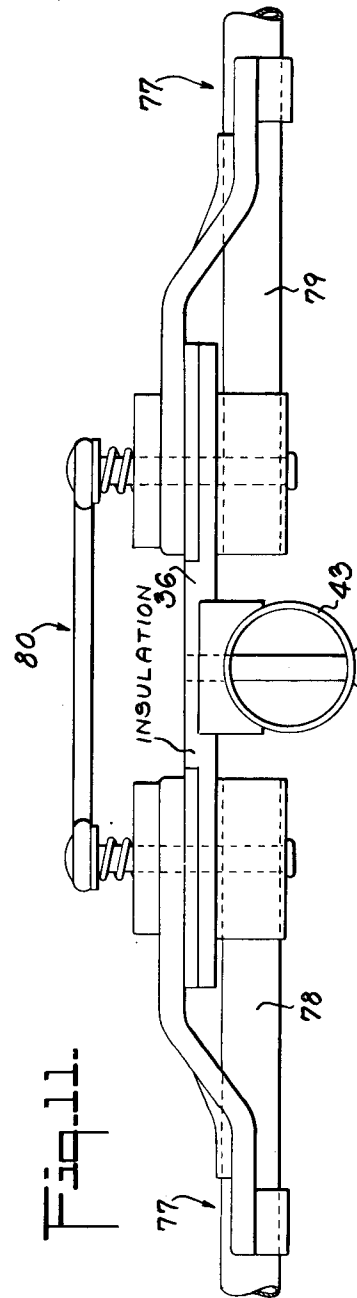
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SHARPLY DIRECTIONAL WIDE BAND ANTENNA

Filed Feb. 12, 1954

5 Sheets-Sheet 5

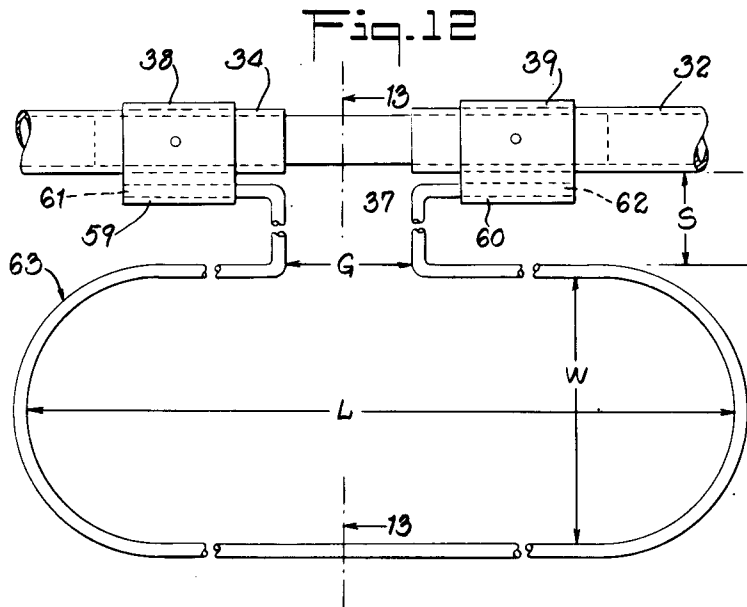
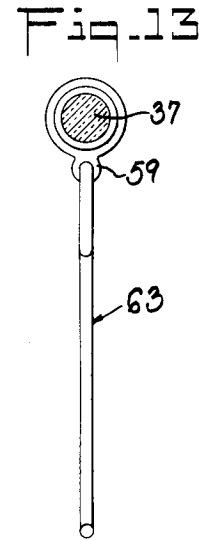
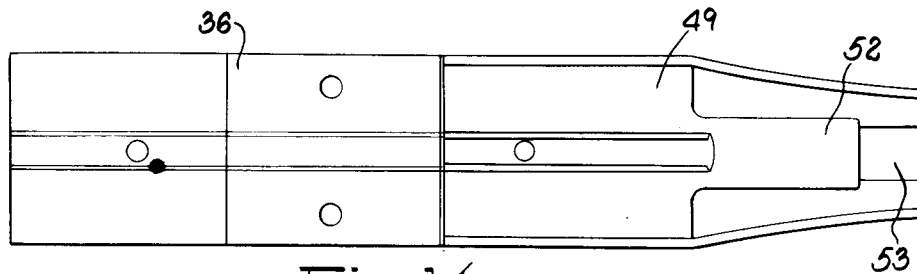


Fig. 14

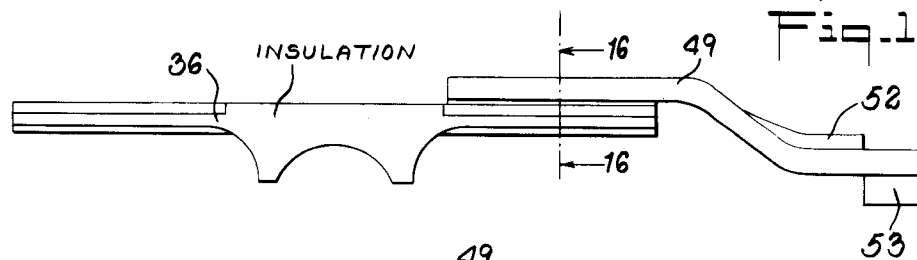


Fig. 15

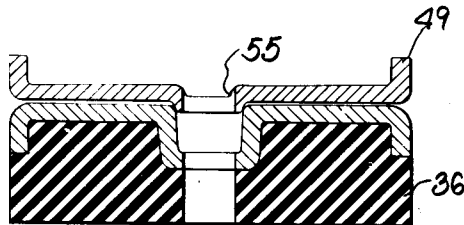


Fig. 16

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SHARPLY DIRECTIONAL WIDE BAND ANTENNA

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Application February 12, 1954, Serial No. 410,004

10 Claims. (Cl. 250—33.51)

This invention relates to radio antennas, and more particularly it relates to antennas which are specially designed for highly directional effects and with high gain over a wide radiation frequency band.

A principal object of the invention is to provide an improved antenna for use over two widely spaced frequency bands, such for example as in receiving present day television frequencies both in the so-called low frequency band of television channels 2 to 6 (54–88 megacycles), and in the higher frequency band of television channels 7 to 13 (174–216 megacycles).

With the advent of so-called compatible color television and with the advent of increased radiation power of existing television transmitters, there has arisen a great need for a more sharply directional, mechanically sturdy and broad radiation frequency band antenna structure. Such an antenna must meet the following requirements.

1. Uniform coverage of low band frequencies in television channels 2–6, and high band frequencies in television channels 7–13, with higher gain on the latter channels.

2. High front-to-back ratio to eliminate co-channel interference or so-called "Venetian Blind" effects encountered with increased transmitter power.

3. Single forward lobe of all channels to meet the rigid requirements of color television wherein "ghosts" show up as washed out tints or shades.

4. The antenna must be physically compact so that it may be readily used with conventional antenna rotators, even when the antenna consists of a single coplanar array or of a multi-planar or stacked array.

5. The terminal impedance must match conventional 300 ohm transmission lines for maximum transfer of signal to the receiver.

6. Multiple stacking must contribute corresponding added gain and corresponding increased sharpening of the field intensity pattern.

In addition to the electrical requirements, the antenna must meet other trade requirements as follows:

A. It must be easily assembled with a minimum of screws and nuts to be tightened.

B. It should not be so bulky as to make handling during erection cumbersome or dangerous to the installer.

C. It should be streamlined and sturdy to stand up in extreme weather and icing conditions.

D. It must have a single boom and be collapsible to fit the smallest package, and also to facilitate stocking in jobbers, and dealers, premises and to permit transportation without danger of breakage.

The present invention has for one of its principal objects an antenna which meets the above-noted requirements.

Another object is to provide a dipole antenna unit having each arm of the dipole sub-divided into one-half wavelength antenna sections by means of an intermediate phase converting unit which is also in the form of a radiation dipole.

Another object is to provide a dipole antenna comprised of a series of co-linear one-half wavelength dipole elements with adjacent elements rigidly and mechanically united in co-linear array and with the said adjacent one-half wavelength elements electrically coupled by a phase correction radiation element.

A feature of the invention relates to a dipole antenna unit having each dipole arm divided into a series of sub-

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dipole sections which are rigidly united in co-linear array and with adjacent sections electrically interconnected by a folded dipole radiation element which increases the broad-banding effect while acting as a phase correction element at the higher frequencies. This phase correction element maintains the same current phase in all serially connected sub-dipole sections while maintaining substantially the same current distribution throughout the various sub-dipole sections.

Another feature relates to an improved broad band antenna of the Yagi type having a series of one-half wavelength co-linear sub-dipole sections.

A further feature relates to a novel Yagi type antenna having at least two driven units, a parasitic reflector unit, the driven units each consisting of a center one-half wavelength dipole section and at least one additional one-half wavelength dipole section at opposite sides of the central section. The central section of each unit is coupled to the adjacent co-linear section by a respective folded dipole radiation element whose longitudinal axis is substantially parallel to, but in spaced relation with, the associated interconnected sub-dipole sections.

A further feature relates to an antenna array of the one-half wavelength dipole type employing at least two separate co-linear arrays, each array being fed from the same transmission line, and each array consisting of a series of serially spaced sub-dipole sections with adjacent sections interconnected by respective folded dipole radiation elements.

A still further feature relates to the novel organization, arrangement and relative location and interconnection of parts which cooperate to provide an improved directional and broad-band radiation antenna. Other features and advantages will be apparent after a consideration of the following detailed description and the appended claims.

In the drawing,

Fig. 1 is a top plan view of an antenna according to the invention;

Fig. 2 is a schematic diagram of one known type of antenna which is useful in explaining the improvements of the present invention;

Fig. 3 is a schematic diagram similar to that of Fig. 2, but illustrating certain improvements in a simple co-linear dipole according to the present invention;

Fig. 3A is a modification of the antenna of Fig. 3;

Fig. 4 shows graphs of the directional field pattern diagrams corresponding respectively to the antennas schematically shown in Figs. 2 and 3;

Fig. 5 is an explanatory diagram of a conventional one-half wavelength dipole antenna used in explaining the invention;

Fig. 6 is a graph of the directional field diagram of the antenna of Fig. 5;

Fig. 7 is an explanatory diagram of the conventional antenna of Fig. 5 when operating at a higher frequency;

Fig. 8 is a graph of the directional field diagram corresponding to the operation of Fig. 7;

Figs. 9, 10, and 11 are respective sectional views of Fig. 1, taken along lines 9–9, 10–10, 11–11 thereof;

Fig. 12 is an enlarged view of part of the antenna of Fig. 1;

Fig. 13 is a sectional view of Fig. 12, taken along the line 13–13 thereof;

Fig. 14 is an enlarged view of one of the swingable bracket supports used in Fig. 1;

Fig. 15 is a front view of Fig. 14;

Fig. 16 is a sectional view of Fig. 15, taken along the line 16–16 thereof.

As is well known, a one-half wavelength dipole, as shown for example in Fig. 5, provides the well-known pattern illustrated in Fig. 6 when its physical length is approximately one-half of the received wavelength. As shown in Fig. 7, at a frequency where the overall physical length of the antenna is one and one-half times the received wavelength (for example the electrical length of a low band antenna operating in the higher frequency band), the pattern changes to a clover leaf as shown in Fig. 8. Here the one and one-half wavelength antenna action requires phase correction since the objectionable breaking up of the field pattern is caused by the inner

one-half wavelength element 10, 11 (Fig. 7), carrying currents in the opposite direction to those in the outer one-half wavelength elements 12, 13, as indicated by the dot-dash curve. It is because of this current distribution that a low band dipole, which, for example, may be designed to operate efficiently over television channels 2-6, fails to give proper gain and pattern response in the higher frequency band, for example channels 7-13. Various devices have been proposed for correcting this condition. However, these prior proposals, while they have corrected the current distribution in the antenna sections, have introduced other undesirable effects.

One proposed solution for this difficulty has been the division of each physical arm of the dipole into separate lengths which are electrically connected by lumped impedances either in the form of a resonant coil and condenser combination, or in the form of so-called impedance stubs or quarter-wave transmission line sections. This latter form of the antenna is illustrated in Fig. 2, wherein the inner dipole sections 10, 11, are connected to their respective outer dipole sections 12 and 13 by the lumped impedance stub lines 14, 15. The stubs 14 and 15 do not act as radiation elements but merely as selective impedance elements to convert the phase of the currents in the sections 12 and 13 so that they are in like phase with the currents in the sections 10 and 11, as indicated by the current distribution curves 16, 17 and 18. However, these stubs do limit the current flow from the center sections 10, 11 to the outer sections 12, 13, since they are in effect high impedance one-quarter wave transmission line sections. Consequently, at resonance, the current in the outer sections 12, 13, is not equal to the current in the center section. This condition results in the limiting of the gain of the antenna at the higher frequencies.

I have found that this limitation can be overcome by interconnecting the central section with the respective outer sections by means of separate radiation elements such, for example, as folded dipole antenna elements. Such a structure is schematically illustrated in Fig. 3, wherein the center sections 10, 11, are connected to their respective outer sections 12, 13, by the folded dipole antenna radiation elements 19, 20. I have found that these elements 19 and 20 perform the triple function of, acting as phase conversion elements, as separate radiation elements, and they also increase the broad-banding effect of the antenna. As a result, the current distribution in all the various sections of the antenna, represented by curves 21, 22, 23, are substantially uniform and the overall current distribution has a smoothly curved characteristic 24, as distinguished from the notched or non-uniform characteristic 26 of the antenna of Fig. 2.

These results are obtained by electrically connecting each folded dipole element 19 in series with the corresponding dipole arm sections. For example, folded dipole 19 is connected in series with arms 10 and 12; and folded dipole unit 20 is connected in series with arms 11 and 13. Each of the folded dipole units 19, 20, can be made of rigid wire or rod and with the longitudinal axis L extending parallel to the respective sections 10 and 12 but preferably spaced a distance D therefrom. Since the folded dipole elements can be made of rod or wire of inherently low impedance they eliminate the blocking effect of one-quarter wave stubs, such as stubs 14 and 15 of Fig. 3, and increase the capture area of the antenna.

The folded dipole elements 19 and 20 act as phase reversing radiation elements whose impedance is constituted of resistance and reactance to provide a much lower "Q" than a one-quarter wave line impedance stub which has only a reactive component. This combination, as illustrated in Fig. 3, provides a broader effective band width to the antenna and increases its effective frequency coverage while increasing its directional effects. There is shown in Fig. 4, by the dotted line curves 27, 28, the directional field intensity pattern of the antenna of Fig. 2, while the full line curves 29, 30, represent the directional field intensity pattern of the improved antenna illustrated in Fig. 3.

While the invention has the above advantages when embodied in a simple co-linear dipole antenna, as in Fig. 3, it also has important advantages in connection with directionalized antennas of the generic Yagi type. Thus, as shown in Fig. 1, the main antenna or driven element is identified by the numeral 31 which is the same as the antenna unit of Fig. 3, comprising a pair of aluminum or

other conductive tubular rods 32, 33, 34, 35, which are supported in spaced co-linear array. Thus, rods 32 and 33, at their inner ends are spaced apart and are suitably anchored to an insulating block or strip 36 (see Fig. 10) which is anchored to the tubular metal cross piece 43. The rod 34 is supported in rigid alignment with rod 32 but insulated therefrom for example by an insulator rod 37 which is tightly fitted at its opposite ends into the tubular members 32, 34. Metal sleeves 38, 39, can be staked on to the members 32, 34 to firmly anchor the rod 37 in place. The rod 37 may be made out of fiberglass or any other suitable insulator effective at high frequency. Likewise, the rod 33 is anchored in rigid alignment with the rod 35 by means of a similar insulator member 40 and the metal fastening sleeves 41, 42.

The members 32, 34 and 37 are mounted for swinging movement as a unit with respect to member 43, as likewise are the members 33, 35 and 40. For this purpose the insulation block 36 has pivotally attached thereto by respective pivot pins 44, 45 (see Fig. 10) a pair of tubular metal members 46, 47, into which the inner ends of rods 32, 33 are fitted. Likewise pivotally attached to the block 36 are metal brackets 48, 49. The ends of these brackets are provided with off-set semi-cylindrical upper and lower tubular portions 50, 51, and 52, 53, to receive the respective antenna arms 32, 33. The undersurface of each of the brackets is provided with a central rib 54, 55 adapted to seat within a corresponding groove or channel in the upper face of block 36. A coiled spring 56 is located between the head 57 of pivot pin 54 and presses against the bracket 48 to hold the parts 48, 36 and 46 in firm resilient engagement. Thus, when the arm 32 is swung to a position where it is perpendicular to member 43, rib 54 snaps into the recess in member 36 to lock the parts against relative swinging. A similar spring 58 is provided for resiliently locking the parts 33, 47 and 49 in a position perpendicular to member 43. In other words, the respective units (32, 34, 37) and (33, 35, and 40) can be swung and detent locked in the relation shown in Fig. 1 when the antenna is being set up. For shipping or storage these units can easily be swung back to a position substantially parallel to member 43 to conserve shipping or storage space. This provides the necessary snap-locking action between the two lateral dipole units and the boom member 43 and does not require any special tools or devices for making sure that the dipole arms are at right angles to the boom. Each of the sleeves 38, 39 has a flange 59, 60 (see Figs. 12 and 13) with a bore therethrough to receive the bent-back ends 61, 62 of the folded dipole antenna element 63 which corresponds to the element 19 of Fig. 3. Likewise there is supported in the flanges 64, 65 of sleeves 41, 42, a similar dipole antenna element 66 which corresponds to element 20 of Fig. 3. Similarly, the members 32, 33 and 34, 35, correspond respectively to elements 10, 11, 12 and 13 of Fig. 3.

The physical length of the two rods 32 and 33, taken together and allowing for the small gap between their adjacent ends, is approximately one-half wavelength to operate as a half-wave dipole in the upper end of the frequency band, e. g., television channels 7-13 (174-216 megacycles). For example, if the antenna is designed to cover the range 54 to 88 and 174 to 216 megacycles, the effective combined length of rods 32 and 33 is approximately 31 inches. Likewise, each of the sections 34 and 35 has a physical length which is approximately equal to that of the combined rods 32, 33. Each of the small folded dipole units 63 and 64 under the above conditions may have a length L of approximately 12 inches, a width W of approximately 2 inches, and a spacing S between the folded dipole and the associated rods 32 and 34 of approximately one and one-quarter inches with the gap G between the ends of the folded dipole approximately 1 inch. In any event under the above frequency assumptions each of the folded dipole units has its highest impedance at approximately 225 megacycles which of course is above the upper frequency of the upper band. Each folded dipole element has substantial distributed reactance considered along the associated antenna rods and is inductive over the entire frequency range of the antenna from 54 to 216 megacycles so that neither of the folded dipole elements is resonant in this range.

Mounted in spaced relation to the main antenna driven unit 31 is another driven unit 67 which is of substantially the same construction as the main driven unit 31 and is

spaced from that driven unit a distance d approximately equal to .34 wavelength at channel 10 and .12 wavelength at channel 4. Here again the unit 67 is formed with a central dipole section consisting of the rods 68, 69, and the associated lateral sections 70, 71. The sections 68 and 70 are rigidly united and insulated from each other in the same manner as the corresponding sections of element 31, and are connected in series by a folded dipole antenna unit 72 which is designed substantially similar to the units 48 and 49 and that unit 72 has its maximum impedance at approximately 225 megacycles, and is non-resonant in the frequency range between 54 and 216 megacycles. A folded dipole unit 73, similar to unit 72, is connected in series between the spaced ends of the rods 69 and 71. The elements constituting the driven unit 67 are supported on the boom 43 in the same manner as described above in connection with antenna 31.

I have found that the best results are obtained where the unit 67, instead of being merely parasitically driven, as is the case in the conventional Yagi antenna, is also driven by being connected to the same transmission line 74 which feeds the antenna 31 by means of metal straps 75, 76. By this arrangement the cumulative energy in the antenna 31 resulting from the direct pick up of the radiations and the parasitic radiations from the driven unit 67 is always combined in phase regardless of the channel used.

In addition to the driven unit 67 there is provided a second parasitically excited director 77 consisting of two one-half wavelength metal rods 78, 79, which are supported in rigid linear alignment and pivotally attached to the boom 43 in the same manner as described for antenna unit 31, and as shown in Fig. 11. The parasitic director 77 is spaced from the driven unit 67 a distance d^1 equal approximately to 0.18 wavelength at channel 10 and .064 wavelength at channel 4. The director 77 is split in the center by a one-quarter wave stub transmission line 80 for maximum efficiency in the high frequency band.

The stub 80 is designed so that it has its maximum impedance at a frequency of 325 megacycles well above the resonant frequency of the folded dipoles 63, 66, 72, 73. Thus, if the folded dipoles are resonant at approximately 460 megacycles, which is well above the upper frequency of 216 megacycles, then the stub 80 can have a minimum impedance at approximately 700 megacycles. In other words, the resonant frequency of each of the folded dipoles is not less than twice the upper operating frequency of the antenna, and the resonant frequency of the stub 80 is not less than three times the said upper operating frequency of the antenna.

The reflector unit 81 for the higher end of the frequency band, for example television channels 7-13, is made up of three rods 82, 83, 84, supported in rigid co-linear array but separated from each other by two insulator spacer rods 85, 86 in the same manner as for the rods 37-40. Here again, the unit is pivotally supported on the boom 43 in the same manner as units 31, 67 and 77. The reflector 81 is spaced from the antenna unit 31 a distance d^2 which is approximately .248 wavelength at channel 10.

The reflector unit 87 for the lower end of the band, for example television channels 2-6, consists of two metal rods 88, 89 (see Fig. 9) and is spaced from the unit 31 a distance d^3+d^4 which is approximately .175 wavelength at channel 4.

Since it is not necessary that the reflector unit 87 be insulated from the boom 43, it is not necessary to employ an insulating strip such as strip 36. The arms 88 and 89 of reflector 87 can be pivotally attached to boom 43 without intervening insulation. Therefore, instead of using an insulator block 36, a metal block 90 can be rigidly fastened to the boom 43, and the arms 88 and 89 can be swingably attached to this block in a manner similar to that described above in connection with the arms 32, 33 and 78, 79.

In accordance with the well-known design principles of reflectors, the physical length of each of the rods 82, 83, 84, should be approximately 1.09 times the length of the corresponding antenna rods 32-33, 34, 35. Likewise, the physical length of unit 87 should be approximately 1.06 times one-half wavelength at channel 2. The director 78 should have a physical length less than one-half wavelength at channel 13, and likewise the

director 79 should have a physical length less than one-half wavelength at channel 10.

The antenna shown in Fig. 1 may be considered as made up of eleven effective one-half wave sections, namely (32-33) 34, 35; (68-69), 70, 71; 78, 79; 82, 83, 84; plus four phase reversing radiation elements 63, 66, 72, 73. This provides a total of fifteen operating antenna elements all of which contribute to the overall performance of the antenna in the higher end of the television band. Considered from another viewpoint, the antenna arrangement consists of three Yagi systems. The first Yagi system comprises elements (32-33), (68-69), 83; the second Yagi system comprises elements 34, 70, 82; the third Yagi system comprises the elements 35, 71, 84. The reflector 87, in addition to acting as a reflector in the lower end of the band, for example television channels 2-6, also acts as a shield which is effective in the higher end of the band to protect the system, when receiving the higher frequencies, from being substantially affected by radiation received from the opposite direction. This increases the front-to-back ratio of the system.

It should be observed that the folded dipole elements 72, 73, 63, 66, do not act as phase reversing elements when the antenna is receiving signals in the lower end of the band, because, in terms of wavelength at those frequencies, the folded dipole units are too small in size to have any phase reversing effect. However, they do have the important function in the low bands of providing mutual coupling across the 2 inch gap, which results in a substantial increase in the "fatness" factor of the associated elements and thus increasing the broad-band efficiency of the antenna. Furthermore, since the folded dipole elements are connected in series circuit with the respective antenna elements, these folded dipole elements also help to raise the impedance of the antenna elements to which they are connected and they effectively increase the element length. Since the folded dipole elements are of distributed reactance as compared with lumped reactance and since they are not constituted of sharply tuned condenser and inductor combinations, their impedance is effective over the entire useful range of the antenna system.

While Fig. 1 shows a single bay antenna system, a vertically stacked series of systems similar to those of Fig. 1 can be mounted in superposed relation on the single vertical supporting mast, as is well-known in the art.

While certain materials and dimensions have been referred to herein, it is done merely by way of illustration and not by way of limitation. Furthermore, while the driven antenna element 31 and the driven element 67 are shown as being composed each of three one-half wave dipole sections connected by means of two intervening folded dipole units, a greater number of such sections and corresponding interconnected folded dipole units may be employed. Furthermore, the Yagi can have more than one drive or connected director. In other words, there may be three or four elements like 31 and 67, rather than merely two, as shown in the drawing. Furthermore, while the antenna has been described as primarily useful as a receiving antenna, it will be understood that it can also be used for transmission.

Various changes and modifications may be made in the disclosed embodiment without departing from the spirit and scope of the invention. For example, while for purposes of lightness in weight the antenna elements are preferably formed from hollow light-weight metal tubing, if desired the antenna units, including the folded dipole phase reversing elements, may be made out of respective single lengths of bendable rigid tubing. This arrangement is illustrated in Fig. 3A, wherein the folded dipole element 19 and the folded dipole element 20 constitutes an integral appropriately bent section at the appropriate point in the length of each of the associated arms.

What is claimed is:

1. An antenna unit comprising at least three co-linear half-wave dipoles consisting of a central dipole section and two lateral dipole sections arranged to operate efficiently over two widely spaced frequency bands for example 54-88 megacycles and 174-216 megacycles, means mechanically uniting all the sections as a co-linear array with the two lateral sections each having a respec-

tive insulated cap between it and the adjacent end of the center section, and separate folded dipole antenna elements each in the form of a flattened loop bridging a respective one of said gaps and each forming an effective radiation element cooperating with the adjacent gapped sections which it bridges, each loop having an electrical length which is approximately a half-wavelength and being resonant at a frequency above the upper frequency range of the antenna unit and spaced from the gapped dipole sections which it bridges, which spacing is a small fraction of the length of a dipole section, each of said folded dipole elements having inherent resistance and capacitance components to provide a broad-banding effect to the antenna unit and each folded dipole element being an effective radiation element for radiation in a direction normal to said co-linear array.

2. An antenna unit according to claim 1 in which each flattened loop dipole element has a major axis and a minor axis and the said spacing between the gapped co-linear dipole sections and the associated bridging flattened loop dipole element is less than one-third the length of the major axis of said element.

3. An antenna unit comprising at least three co-linear half-wave dipoles consisting of a central section and two lateral sections arranged to operate efficiently over two widely spaced frequency bands for example 54-88 megacycles and 174-216 megacycles, means mechanically uniting all the sections in a co-linear array unit with the two lateral sections each having a respective insulated gap between it and the adjacent end of the center section, and separate folded dipole antenna elements each in the form of a flattened loop bridging a respective one of said gaps and each forming an effective radiation element cooperating with the gapped sections which it bridges to bring the currents in said sections into like phase at the higher one of said frequency bands, each folded dipole element having a major axis substantially parallel to said co-linear array which major axis has a length which is approximately 0.2 wavelength at a chosen frequency within said higher band, and having a minor axis which is approximately 0.033 wavelength at said chosen frequency, the side of folded dipole element adjacent said co-linear sections being spaced therefrom a distance of approximately 0.02 wavelength at said chosen frequency, each folded dipole element being an effective radiation element over both said bands for radiation mainly in a direction normal to said co-linear array.

4. An antenna unit according to claim 3 in which each of said gaps is approximately 0.018 wavelength at said chosen frequency.

5. An antenna unit according to claim 1 in which adjacent gapped co-linear sections are located in the same plane as the folded dipole element which bridges the gap therebetween to provide substantial mutual coupling and energy transfer between the said sections which said folded dipole element bridges.

6. An antenna unit according to claim 5 in which each of said folded dipole elements forms a phase inverter for frequencies in the upper one of said bands while providing mutual coupling between its bridged co-linear sections in the lower one of said bands.

7. An antenna system including at least two similar

antenna units each unit comprising at least three co-linear half-wave dipoles consisting of a central dipole section and two lateral dipole sections arranged to operate efficiently over two widely spaced frequency bands for example 54-88 megacycles and 174-216 megacycles, means mechanically uniting all the sections as a co-linear array with the two lateral sections each having a respective insulated gap between it and the adjacent end of the center section, and separate folded dipole antenna elements each in the form of a flattened loop bridging a respective one of said gaps and each forming an effective radiation element cooperating with the adjacent gapped sections which it bridges, each loop having an electrical length which is approximately a half-wavelength and being resonant at a frequency above the upper frequency range of the antenna unit and spaced from the gapped co-linear dipole sections which it bridges, which spacing is a small fraction of the length of a dipole section, each of said folded dipole elements having inherent resistance and capacitance components to provide a broad-banding effect to the antenna unit and each folded dipole element being an effective radiation element for radiation in a direction normal to said co-linear array, means to support both said antenna units in substantial parallelism, and means for connecting the central sections of each unit to a transmission line.

8. An antenna system according to claim 7 in which there is provided for the higher frequency band a first parasitic reflector array which is mounted in spaced parallelism with both of said units, said parasitic array comprising a central section in alignment with the central dipole sections of each of said antenna units, said parasitic array also including lateral sections each in alignment with the corresponding lateral sections of both of said antenna units, the central section and lateral sections of said parasitic array being co-linear and insulated from each other.

9. An antenna system according to claim 8 in which there is provided for the lower frequency band a separate parasitic reflector array which is mounted in spaced parallelism with the first parasitic array.

10. An antenna system according to claim 9 in which a parasitic director array is mounted in spaced parallelism with said antenna units, said parasitic director array comprising a pair of co-linear elements with an insulated gap between the adjacent ends thereof and a quarter-wave stub transmission line bridging said gap between said co-linear parasitic director elements, said stub line having a resonant frequency well above the upper operating frequency of the antenna system.

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