

June 30, 1959

J. K. KOBLER

2,893,004

DUAL BAND ANTENNA ARRAY

Filed Dec. 23, 1955

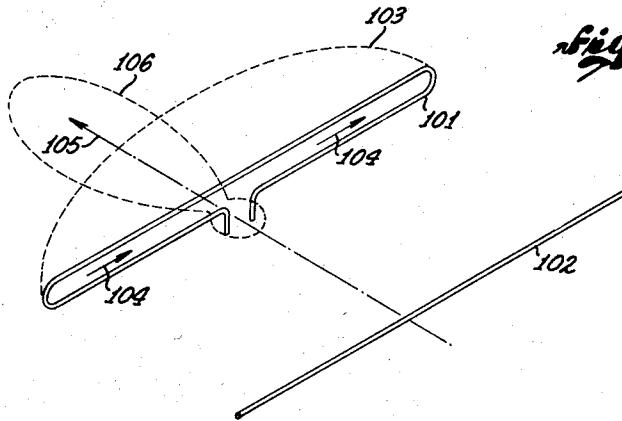


fig. 1.

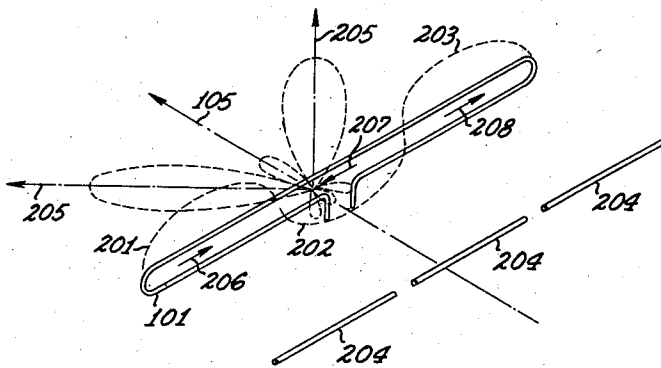


fig. 2.

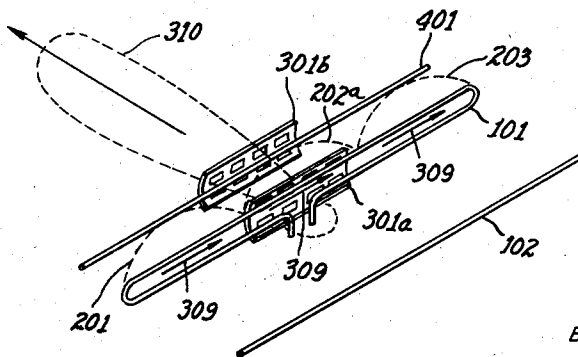


fig. 3.

JAN K. KOBLER,
INVENTOR.

HUEBNER, BEEHLER,
WORREL & HERZIG,
ATTORNEYS.

BY

Albert M. Herzig

1

2,893,004

DUAL BAND ANTENNA ARRAY

Jan K. Kobler, Los Angeles, Calif., assignor, by mesne assignments, to Finney Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Application December 23, 1955, Serial No. 555,097

10 Claims. (Cl. 343—818)

This invention relates to linear antenna arrays, and more particularly to a single linear antenna array of the yagi type for operation at its fundamental half wavelength resonant dimension and at its corresponding three-half wavelength resonant dimension with substantial identity of its directional characteristics.

Present day VHF television broadcasting in the United States and many parts of the world is accomplished on two bands, 54–88 mc. and 174–216 mc. A half-wave dipole antenna for television reception, designed to be resonant in the low VHF band and centered at 66 mc. is resonant also at its three half-wave dimension in the high VHF band centered at 198 mc. The current distribution curve of a dipole at its half-wave low VHF band resonant frequency is a single loop with maximum current at the center and zero at either end of the dipole. With a parasitic reflector an antenna such as the half-wave dipole has the familiar dipole radiation pattern involving a single forward lobe and substantially no backward lobe.

The current distribution curve of the same antenna at the three half-wave length resonant frequency has three half-wave current loops. The center half-wave current loop has an opposite phase direction to the outer half-wave current loops. The phase reversal of the current loop of the center half-wave section of the antenna at its three-half wave frequency results in a butterfly-shaped radiation pattern. The butterfly-shaped radiation pattern is very undesirable for television reception because the forward lobe is almost cancelled and the maximum sensitivity is in two directions each at an angle of approximately 43° on either side of the forward direction. While the dipole is thus satisfactory for the low VHF band, such an antenna arrangement is not satisfactory for dual band operation for television reception on both the low and the high VHF bands.

If the phase of the half-wave current distribution loop of the center half-wave section of the three half-wave-length antenna can be inverted to be in phase with the current loop of the outer half-wave sections, the resulting current distribution curve will then have three half-wave current loops in the same phase. The radiation pattern of the antenna may be corrected in this way to make it useful for unidirectional television reception on the high VHF band as well as on the low VHF band. The gain of the antenna on the high band is increased and the forward lobe of the high band radiation pattern sharpened as if three separate half-wave antennas are lined up in a collinear array.

A number of solutions to the phase reversal problem have been reported in the literature, and some are in actual use. These solutions have included the connection of certain complex additional high-band resonant antenna structures to the low-band antenna. One of these involves a pair of high-band dipoles connected in parallel with each other and out of phase with the low-band dipole. The high-band dipoles are a half-wave-length long at three times the resonant frequency of the

2

low-band antenna. This antenna structure includes a complex of three driven elements to effect dual band operation. The system necessitates quarter-wave impedance matching stubs in each driven element termination to maintain a satisfactory impedance match on both high and low bands. The required interconnecting harness is cumbersome and critical as to adjustment and positioning with respect to the remainder of the antenna array.

Another solution to the problem of reversing the phase of the center half-wave current loop at the third harmonic operation of a low-band TV (television) receiving dipole involves the insertion of a quarter-wave stub element shaped like a folded dipole in each half of the driven element of the low-band antenna. The folded dipole shaped stub elements connecting the main elements of the dipole have a lower "Q" than similarly used purely reactive stub elements. This necessitates multiplication of driven elements to increase the antenna sensitivity.

Other solutions proposed have also required additional elements connected to the driven element or have required a plurality of driven elements to obtain satisfactory results on both low-band and high-band TV frequencies.

More recently, as disclosed and claimed in U.S. patent to Weiss, Re. 24,413, it has been proposed to use a novel phase reversing means in association with a driven dipole to render it effective for both low and high-band TV reception. The novel phase reversing means of the Weiss Patent is a parasitic (i.e., non-driven) dipole disposed in closely spaced parallel relationship with the driven dipole and being coextensive with approximately the central one-third of the driven dipole. The effect of this parasitic element is to reverse the phase of the current in the central portion of the driven dipole when it is operating at or near its three half-wave resonant frequency. This gives the driven dipole essentially a two-lobe radiation pattern at such frequencies (as well as at or near the one half-wave resonant frequency of the driven dipole). As disclosed by Weiss, conventional directors and/or reflectors may be used in combination with such an array, with the usual effects.

The principal object of the present invention is to provide a driven dipole having phase reversing means to render it responsive with similar directional characteristics in both the low and high television bands, and also having a parasitic array associated therewith which will enhance the gain of the driven dipole at low-band frequencies without impairing its operation at high-band frequencies, and which may also enhance its operation at high-band frequencies without impairing its operation at low-band frequencies.

The present invention involves a driven dipole cut to operate as a half-wave dipole in a low frequency band and having means associated therewith for also giving it essentially a two-lobe radiation pattern at a higher frequency approximately three times the medial, low-band frequency. This means so associated with the driven dipole, for example, may be a parasitic ("non-driven") dipole that is closely spaced in front of the driven dipole, as disclosed and claimed by Weiss. In addition, the present invention involves an appropriate other parasitic element, for example, a low-band director, and a parasitic phase reversing element associated therewith to render it effective at both the low and high-band frequencies to which the driven dipole with its phase reverser is responsive.

The principal advantages of this arrangement are that a low-band director, for example, may be cut to its optimum length for enhancing the forward gain of the driven dipole in its low-band range of operation; and, by employing the phase reversing element associated with the director, the director is apparently caused to function

3

at high-band frequencies essentially as a three-element high-band director so as to enhance the forward gain of the antenna array in its high-band range of operation, without impairing the normal operation of the array as a whole or of the director in the low-band range.

These and other objects, features, and advantages of this invention will become apparent from the following specification and claims taken together with the accompanying drawings, in which two illustrative prior art antennas and an illustrative embodiment of the invention are shown.

In the drawings:

Figure 1 is a drawing of the basic half-wave dipole antenna to show characteristics thereof;

Figure 2 is a diagram of an antenna array showing characteristics the correction of which is accomplished by this invention; and

Figure 3 is a diagrammatic representation of an antenna embodying the invention.

Referring now to Figure 1, there is shown an elementary half-wave folded dipole 101 and a reflector parasitic element 102. It is well known that such an antenna structure, operating at its half-wave resonant frequency, has an instantaneous current distribution such as represented by the dotted half sine wave curve 103. The instantaneous phase direction of this current may be represented by arrows 104. The arrow 105 shows the direction in which this antenna has a maximum sensitivity when used as a receiving antenna. For illustrative purposes, this antenna may be considered to be resonant at 66 mc., but not limited to operation at this frequency.

The antenna 101 shown in Figure 2, to which reference is now made, embodies a folded dipole 101 that is identical with that shown in Figure 1, which bears the same reference character. As represented in Figure 2, at a frequency three times that at which the antenna of Figure 1 is operated, antenna 101 is a three half-wave dipole. The current distribution curve for a three half-wave dipole is shown at 201, 202, and 203. The three parasitic reflector elements shown at 204 are each one half-wave length long at the three half-wave operating frequency or the exemplary 198 mc. The maximum directions of sensitivity of an antenna such as shown in Figure 2 are in the directions of arrows 205, each of which is at an angle of 43° off center. Thus, for the three half-wave operation of the half-wave dipole 101, the directivity is in two directions. The dual directivity is the result of the fact that the central current loop 202 is out of phase with the outer loops 201 and 203, as shown by arrows 206, 207, and 208.

In order to make this antenna more useful for television reception at, say, 198 mc., it should be made sensitive only in a single direction, as shown by arrow 105 for the 198 mc. operation of the antenna array, as well as for operation at 66 mc. To accomplish this it is necessary to provide means for inverting the phase of central current loop 202 so that it is in the same phase as loops 201 and 203.

One example of how this may be done in accordance with the present invention is shown in Figure 3. The phase reversing elements 301a and 301b of the invention are broad, generally rectangular, metal pieces dimensioned for one half-wave resonance at the three half-wave frequency of the same driven folded dipole 101 shown in Figures 1 and 2. The phase reversing elements 301a and 301b may be mounted directly on conventional antenna supporting structure (not shown) or may be insulated from it. The shape of the pieces 301a and 301b may be varied for mechanical strength or wind conditions, and for optimum radiation properties. The phase reversing element 301a may be positioned in close proximity to the driven dipole 101. The phase reversing element 301b may be positioned in close proximity to a low-band parasitic element such as a low-band director 401. Both of

4

the elements 301a and 301b are centrally aligned with the driven dipole 101 and the director 401, as shown.

The resultant effect of the phase reversing element 301a on the current distribution in the driven dipole 101 is that the central current loop 202 of Figure 2 is inverted as shown at 202a in Figure 3. Thus, all three current loops 201, 202a, and 203 in the driven element 101 are in phase and have a common phase direction as indicated by arrows 309.

In addition to the foregoing elements, the antenna of Figure 3 may include a conventional reflector 102 identical with the reflector of Figure 1.

As a result of this phase reversal of the central current loop, an antenna array such as shown in Figure 3 has a directivity pattern as at 310 at its three half-wave frequency.

If the low-band director 401 were to be included in the antenna of Figure 3 to enhance the low-band gain, without including the phase reverser 301b, it would generally seriously impair the operation of the antenna on high band. However, in accordance with this invention, I have found that this effect may be avoided by also including the phase reverser 301b, without in any respect impairing the normal action of the director 401 on low band. At the same time, inclusion of the phase reverser 301b gives it the characteristics of a three-element, collinear, high band director, and generally enhances the high-band gain compared to what would be obtained without either the director 401 or phase reverser 301b.

The result is that the inclusion in the antenna of Figure 3 of both the high-band director 401 and its associated phase reverser 301b enhances the gain of the antenna on low-band without any adverse effect on the high-band operation achieved by associating the phase reverser 301a with the driven dipole 101, and generally will also enhance the high-band gain.

While I have herein shown and described my invention in what I have conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of my invention, which is not to be limited to the details disclosed herein, but is to be accorded the full scope of the claims so as to embrace any and all equivalent structures.

What is claimed is:

1. An antenna comprising a driven dipole dimensioned for operation as a half-wave dipole at a first selected frequency, means associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a non-driven conductor dimensioned and spaced from said driven dipole for operation as a half-wave parasitic element for the driven dipole at said first frequency, said driven dipole and said parasitic conductor being disposed one in front of the other with respect to a direction of maximum sensitivity of the antenna, and a parasitic phase reversing element dimensioned for half-wave resonance at approximately said second frequency, said phase reverser being disposed in closely spaced parallel relationship with the center portion of said non-driven conductor.

2. An antenna comprising a driven folded dipole dimensioned for operation as a half-wave radiating element at a first selected frequency, means associated therewith for giving said folded dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a non-driven conductor dimensioned and spaced from said folded dipole for operation as a half-wave parasitic element for the folded dipole at said first frequency, said folded dipole and said parasitic conductor being disposed one in front of the other with respect to a direction of maximum sensitivity of the antenna, and a parasitic phase reversing element dimensioned for half-wave resonance at approximately said second frequency, said phase reverser being disposed in closely spaced parallel relation-

ship with the center portion of said non-driven conductor.

3. An antenna comprising a driven dipole dimensioned for operation as a half-wave dipole at a first selected frequency, means associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a non-driven conductor dimensioned and spaced from said driven dipole for operation as a half-wave parasitic element for the driven dipole at said first frequency, said driven dipole and said parasitic element being disposed one in front of the other with respect to a direction of maximum sensitivity of the antenna, and a parasitic phase reversing element dimensioned for half-wave resonance at approximately said second frequency, said phase reverser being disposed in closely spaced parallel relationship with the center portion of said parasitic element on the opposite side thereof from the driven dipole.

4. An antenna comprising a driven dipole dimensioned for operation as a half-wave dipole at a first selected frequency, phase reversing means associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a first non-driven conductor dimensioned and spaced from said driven dipole for half-wave resonance as a parasitic element for the driven dipole at approximately said first frequency, said driven dipole and said non-driven conductor being disposed one in front of the other with respect to a direction of maximum sensitivity of the antenna, and additional phase reversing means for said non-driven conductor, said additional phase reversing means comprising a second non-driven conductor dimensioned for half-wave resonance at approximately said second frequency and disposed in closely spaced parallel relationship with the center portion of said first non-driven conductor.

5. An antenna comprising a driven dipole dimensioned for operation as a half-wave dipole at a first selected frequency, first parasitic phase reversing means associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency and comprising a non-driven conductor dimensioned for half-wave resonance at said second frequency, a second non-driven conductor dimensioned and spaced from said driven dipole for operation as a half-wave parasitic element at said first frequency, said driven dipole and said second non-driven conductor being disposed one in front of the other with respect to a direction of maximum sensitivity of the antenna, and second parasitic phase reversing means for said second non-driven conductor, said second phase reversing means comprising a third non-driven conductor dimensioned for half-wave resonance at approximately said second frequency, said third non-driven conductor being disposed in closely spaced parallel relationship with the center portion of said second non-driven conductor.

6. An antenna comprising a driven dipole dimensioned for operation as a half-wave dipole at a first selected frequency, means associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a parasitic director dimensioned as a half-wave director at said first frequency and disposed in directive

relationship in front of said driven dipole, and a parasitic phase reversing element dimensioned for half-wave resonance at said second frequency, said phase reverser being disposed in closely spaced parallel relationship with the center portion of said director.

7. An antenna comprising a driven folded dipole dimensioned for operation as a half-wave radiating element at a first selected frequency, means associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a parasitic director dimensioned as a half-wave director at said first frequency and disposed in directive relationship in front of said driven dipole, and a parasitic phase reversing element dimensioned for half-wave resonance at said second frequency, said phase reverser being disposed in closely spaced parallel relationship with the center portion of said director.

8. An antenna comprising a driven dipole dimensioned for operation as a half-wave dipole at a first selected frequency, means associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a parasitic conductor dimensioned as a half-wave parasitic element at said first frequency and disposed in spaced directive relationship with said driven dipole, and a parasitic phase reversing element dimensioned for half-wave resonance at said second frequency, said phase reverser being disposed in closely spaced parallel relationship with the center portion of said director on the opposite side thereof from the driven dipole.

9. An antenna comprising a driven dipole dimensioned for operation as a half-wave dipole at a first selected frequency, phase reversing means associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a parasitic director dimensioned as a half-wave director at said first frequency and disposed in directive relationship in front of said driven dipole, and a parasitic phase reversing dipole element dimensioned for half-wave resonance at said second frequency, said parasitic phase reverser being disposed in closely spaced parallel relationship with the center portion of said director.

10. An antenna comprising a driven folded dipole dimensioned for operation as a half-wave dipole at a first selected frequency, a parasitic phase reversing dipole element associated therewith for giving said dipole essentially a two-lobe radiation pattern at a second frequency approximately three times said first frequency, a parasitic director dimensioned as a half-wave director at said first frequency and disposed in directive relationship in front of said driven dipole, and a second parasitic phase reversing dipole element dimensioned for half-wave resonance at said second frequency, said phase reverser being disposed in closely spaced parallel relationship with the center portion of said director on the opposite side thereof from said driven dipole.

References Cited in the file of this patent

UNITED STATES PATENTS

2,580,798	Kolster	Jan. 1, 1952
2,691,730	Lo	Oct. 12, 1954
2,705,283	Thomas	Mar. 29, 1955
2,726,390	Weiss	Dec. 6, 1955