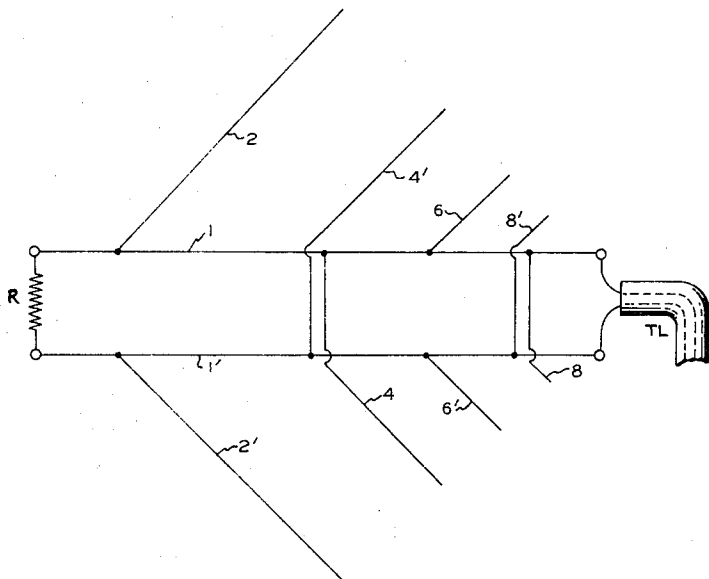


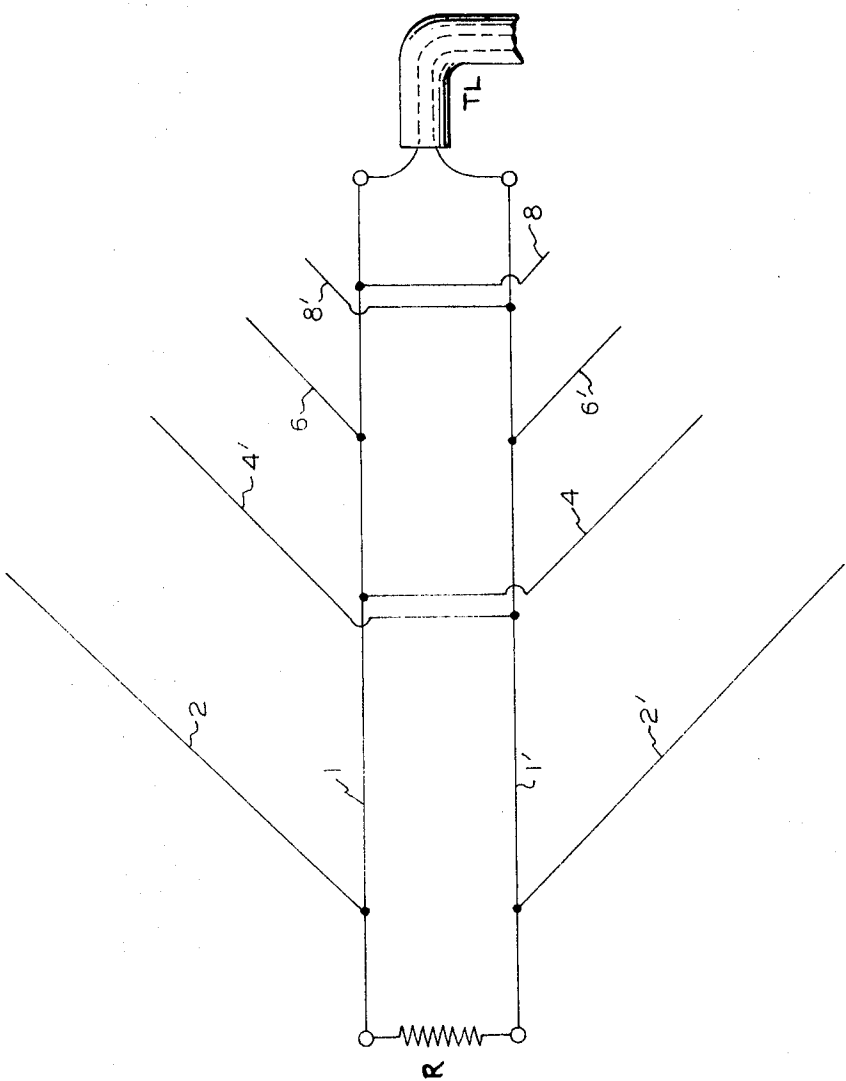
[72] Inventor **Isaac S. Blonder**
Claycourt, N.J.
[21] Appl. No. **835,979**
[22] Filed **June 24, 1969**
[45] Patented **July 27, 1971**
[73] Assignee **Blonder-Tongue Laboratories, Inc.**
Newark, N.J.

[56] **References Cited**
UNITED STATES PATENTS
2,242,023 5/1941 Cork et al. 343/740
3,221,332 11/1965 Kravis et al. 343/792.5
Primary Examiner—Eli Lieberman
Attorney—Rines and Rines

[54] **SECONDARY LOBE AND GHOST-REDUCTION
ANTENNA TRANSMISSION-LINE SYSTEM**
4 Claims, 1 Drawing Fig.
[52] U.S. Cl. **343/792.5,**
343/740, 343/811
[51] Int. Cl. **H01q 11/10**
[50] Field of Search **343/739,**
740, 792.5, 811, 814, 815

ABSTRACT: This disclosure deals with a novel antenna apparatus embodying a nonradiating transmission line section feeding active antenna dipole elements and the like for operation over a multifrequency range, wherein use is made of resistance connected at a critical location across the nonradiating transmission line section for enabling the reduction of secondary lobes and interference in antenna reception or equivalent problems in antenna transmission.





INVENTOR
ISAAC S. BLONDER

BY *Rines and Rines*
ATTORNEYS

SECONDARY LOBE AND GHOST-REDUCTION ANTENNA TRANSMISSION-LINE SYSTEM

The present invention relates to antennas, being more particularly directed to multifrequency antenna systems, such as dipole arrays used for the reception of VHF and other television bands and the like, including log periodic and similar arrays operating in multiwavelength modes, such as the fundamental, half-wavelength and three-halves wavelength modes, to enable reception over the wide frequency bands of interest with substantially uniform gain, directivity and other performance characteristics. Though described hereinafter in terms of the reception of radio wave energy, the principles of the invention are equally applicable to transmission; the term "nonradiating" as used herein in connection with the two-conductor transmission line section to which the active antenna elements are connected, being generically intended to embrace interaction with radio waves in space both in the reception and transmission processes.

From a more particular point of view, the invention is of important utility with log periodic dipole arrays operating in the fundamental and three-halves wavelength modes, wherein the antennas are fed by spaced-conductor transmission line or boom sections that are of length that is quite finite in terms of the wavelength of the energy, and as distinguished from very long wavelength systems wherein many of the problems underlying the invention do not occur.

In my previous U.S. Letters Pat. No. 3,259,904, issued July 5, 1966 for Directive Antenna, such a log periodic antenna is disclosed particularly adapted for the reception of television signals and the like. While this antenna has found wide and successful application for its intended purposes, difficulties have come to light in those systems wherein the length of the transmission-line section or booms supporting the antenna dipole elements must be rather short in terms of the wavelengths of the energy at the lowest utilized frequencies, and/or where, for purposes of economy, space and other considerations, the number of employable dipole antenna elements of different dimensions for the different frequencies in the band must be quite limited, such that the area for radiation or reception or interaction with the radio field in space is relatively limited. In the circumstances of such specific antenna systems, the limited dimensions and limited number of dipoles or other antenna elements do not present a sufficient area fully to interact with space and adequately to abstract received energy and transmit the same to the feed transmission line. Excess energy in the transmission-line sections immediately associated with such limited-dimension antenna systems, indeed, will travel down the line and reflect back, deleteriously exciting the various dipole elements with different and improper phases and directions of the radio-frequency currents; such that undesired side-lobes and back-lobes are produced in the radiation pattern which manifest themselves, in the case of television reception, in ghost images and other interfering effects.

An object of the present invention, accordingly, is to provide a new and improved multifrequency relatively limited-dimension system of the above-described character that provides for the reduction of undesired side-lobe, back-lobe, ghost and similar interference effects despite the limited radiating area or size of the system.

In the specific case of log periodic dipole arrays operating in the three halves-wavelength mode, for example, with the vertically separated two boom or conductor transmission-line section forming the support and immediate transmission-line connection with the active dipole antenna elements, as described in said Letters Patent, resonance bands or traps generally occur at different of the frequencies as a result of the before-mentioned reflections and improper direction of spurious currents and the like along the booms or conductors of the dipole-supporting transmission-line section. Depending upon the length of such transmission-line section, and whether the

booms are left open-circuited at the end opposite the feed and or are there-provided with a shorting stub (both of which techniques have long been used in this art), effective short circuits can appear at different of the dipole elements. This, in effect, removes that element as a functioning antenna from the array and introduces deterioration in the radiation pattern, including the side-lobes and other effects before discussed.

Techniques have heretofore been employed to try to obviate this problem. When a short circuit is applied between the two booms of the transmission-line section supporting the dipole or other antenna elements, for example, an open-circuit condition appears at various locations corresponding to quarter-wavelength points or odd multiples thereof along the line section. At points corresponding to multiples of the half-wavelengths, however, short-circuiting effects occur which will reduce the gain, upset the phase, and distort the pattern. To try to avoid these short-circuit trapping effects within the particular frequency bands of interest, structures are employed to tune the same to frequencies outside such bands. When this is done in connection with say, the frequencies at the upper end of the VHF television band, unfortunately, it is found that a deleterious effect occurs for operation at frequencies in the low end of the fundamental wavelength mode of operation of the antenna, say, near the 54 Megahertz (MHz.) channel of the lower part of the VHF band. Thus the efforts to avoid the trapping effects in the three-halves wavelength mode produces deterioration in the fundamental mode operation at the low end of the television band. This is, however, the best that the art has been able to do as a compromise in this situation.

A further object of the invention, accordingly, is to provide a novel type of transmission-line termination and system that, particularly in connection with antennas of the above-described type, viates the disadvantages above-discussed and provides a much more suitable solution to the problem of avoiding traps in the upper end of the VHF television band without the same degree of degradation of the very low channel pattern and reception.

Other and further objects will be explained hereinafter and will be more particularly pointed out in connection with the appended claims.

In summary, the invention contemplates a multifrequency antenna having a substantially nonradiating two-conductor transmission line section of predetermined characteristic impedance provided at a plurality of longitudinally spaced locations therealong with antenna elements extending transversely therefrom and of different dimensions corresponding to different of the multifrequencies. Feed transmission line means is connected at one end of the section and resistance is connected across or between the two conductors of said section near the other end, the resistance being adjusted to a value greater than the said predetermined characteristic impedance of the transmission-line section. Preferred details are hereinafter set forth.

The invention will now be described in connection with the accompanying drawing, the single figure of which illustrates a preferred embodiment of the invention in schematic form, shown applied, for purposes of illustration, to the log periodic V-type of reception antenna; though, as before stated, the invention is also equally useful in other antennas, as well.

Referring to the drawing, a substantially nonradiating two-conductor open wire transmission line section is shown provided at 1 and 1', comprising vertically spaced booms or conductors supporting dipole antenna elements at 2, 2', 4, 4', 6, 6', 8, 8', etc., that extend transversely therefrom at longitudinally spaced locations therealong. Successive antenna pairs are schematically shown oppositely connected to reverse phase thereof, with dipole elements 2, 4, 6 and 8 lying in an upper substantially horizontal plane containing conductor 1, and dipole elements 2', 4', 6' and 8' lying in a lower substantially horizontal plane containing conductor 1'. The dimensions of the antenna elements and the spacing therebetween preferably vary substantially in accordance with the log

periodic distribution law as taught in the said U.S. Letters Patent. As before stated, however, the invention is also useful with arrays that do not follow this law, but in which there is also concern with providing antenna elements that enable multifrequency reception by the array.

The front or right-hand end of the two-conductor transmission-line section 1, 1' is shown connected to a parallel wire twin-lead feed transmission line TL as discussed in said Letters Patent. At the other end of the two-conductor transmission line section 1 and 1', in accordance with the present invention, there is further connected, across or between the two conductors, an actual resistance R.

While resistance has been used in radiating antenna structures where the transmission line is itself the radiator, as in rhombic and zigzag antennas and the like, this is for purposes of providing a resistive termination that will absorb energy in one direction and eliminate standing waves; and, for such purposes, the value of such resistors are related to the characteristic impedance of the system in order to attain the necessary impedance match. The present invention, to the contrary, will be observed to be concerned with placing resistance not on a transmission line that is serving as a radiator, but, to the contrary, across a flat or substantially nonradiating transmission line section 1, 1' that does not radiate or receive from space, but that supports and feeds the active elements that do have such interaction. In such transmission lines of the nonradiating type, the use of any resistance across the lines has heretofore been entirely contraindicated by the long history of this art, since, among other reasons, it absorbs desired energy—a disadvantageous characteristic in such prior systems.

In accordance with the present invention, on the other hand, it has been discovered that a most unexpected and highly advantageous result can be obtained by appropriately using such resistance R across the nonradiating transmission line section 1, 1', in the case of active antenna elements that are sufficiently so limited in dimensions and number as to preclude an effective radiation area large enough fully to abstract or transmit energy from or into space. Though, at first blush, it would seem that the use of such a resistance across the nonradiating transmission-line section would reduce the receiving pickup of the system because of the additional load and thus serve an entirely undesirable purpose, as well as mismatching to the line, quite the contrary has been discovered to occur, particularly where multimode operation of multifrequency bands is concerned and where only a few dipole elements are used with a length of nonradiating transmission-line section 1, 1' that is short in terms of wavelengths. Specifically, it has been discovered that if a value of resistance R is selected that is several times the effective characteristic impedance of the transmission-line section 1, 1' (as loaded by the antenna dipole elements), that secondary lobes and ghosts are very much reduced and, indeed, substantially eliminated, and without the degeneration in the very low band reception, previously discussed.

The explanation appears to reside in the fact that, whereas a short circuiting stub across one of the dipole elements will result in reflections along the transmission-line section 1, 1', introducing secondary lobes, ghosts or other destruction of the pattern, the effect of such short circuit becomes obviated by the present invention since a finite impedance is provided with an appropriate resistance R, connected as shown. Thus, reflections have been found to produce a negligible effect, and do not cause short-circuiting in these small-dimensioned systems, that disadvantageously occur with open- or short-circuit terminations of the left-hand end of the two-conductor transmission line sections of prior-art arrays. While such a resistance R has been found to dissipate some of the energy

received by the longest element both in the one-half wavelength and the three-halves wavelength modes, it has been found that in the three-halves mode, the longest element (tuned well below, say 174 to 180 MHz.) is unaffected by the presence of the resistance R. In the one-half wavelength mode, the longest element (54 to 60 MHz.) will, it is true, have some of its energy dissipated in the resistance R; but this has been found, with the critical values before discussed, to provide better performance than with the prior art terminations. It has, indeed, been observed that such construction does not deteriorate the front-to-back ratio of the pattern in any significant way, as compared with the deterioration in the low end of the VHF band that, in prior systems, has resulted from short-circuiting techniques for tuning the traps above the high frequencies in the three-halves wavelengths mode of operation.

It has been discovered that values of resistance R in the case, for example, of 150 to 180 ohm effective characteristic impedance of the transmission-line section 1, 1', that will attain the above results when connected to the left-hand side of the longest radiating antenna elements 2, 2', is in the range of from 330 ohms to about 800 ohms (substantially 2 to 5 times such characteristic impedance); with optimum results appearing to occur in some cases of transmission-line sections 1, 1' of the order of three-quarters of the longest wavelength, for a resistance value of about 660 ohms.

Further modifications will occur to those skilled in the art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. A multifrequency antenna system operating in multiwavelength modes and having a substantially nonradiating two-conductor open-wire transmission-line section of predetermined characteristic impedance provided at a plurality of longitudinally spaced locations therealong with dipole antenna elements extending transversely therefrom and of different dimensions corresponding to the different wavelengths of the multifrequencies, the said dimensions being successively arranged substantially with a log periodic distribution, a parallel conductor twin lead feed transmission-line means connected near one end of the section, and resistance connected between the two conductors of said section near the other end and of value greater than the said predetermined characteristic impedance of said transmission-line section, said other end being adjacent the longest-dimensioned dipoles of the system.

2. A multifrequency antenna system as claimed in claim 1, in which the said value of said resistance is several times the said predetermined characteristic impedance.

3. A multifrequency antenna system as claimed in claim 1, and in which the said predetermined characteristic impedance is of the order of 150—180 ohms and said resistance value is from substantially 2 to 5 times the same.

4. A multifrequency antenna system operating in multiwavelength modes and having a substantially nonradiating two-conductor parallel-wire transmission-line section of predetermined characteristic impedance provided at a plurality of longitudinally spaced locations therealong with dipole antenna elements extending transversely therefrom and successively longer dimensions corresponding to the different wavelengths of the multifrequencies, a twin-lead feed transmission-line means connected near one end of the section, and resistance connected between the two conductors of said section near the other end, adjacent to the longest dimensioned dipole elements, and of value from substantially 2 to 5 times the said predetermined characteristic impedance of said transmission-line section.