March 5, 1940. M. KATZIN 2,192,532

DIRECTIVE ANTENNA

Filed Feb. 3, 1936

Fig. 1

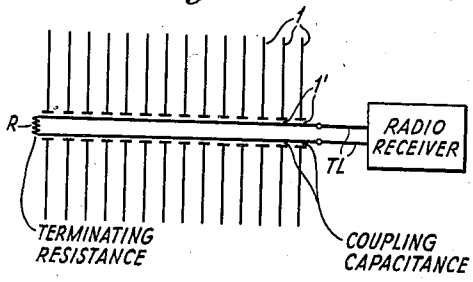


Fig. 2

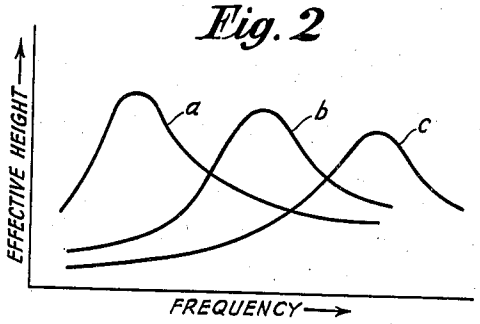


Fig. 3a

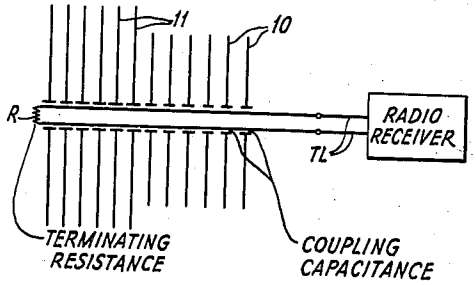


Fig. 3b

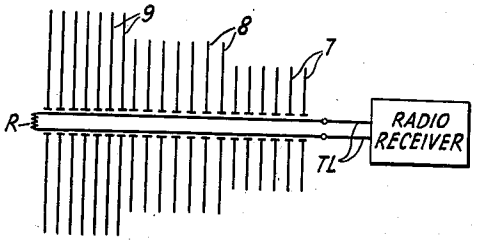


Fig. 3c

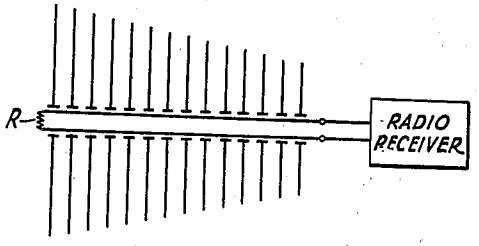


Fig. 4

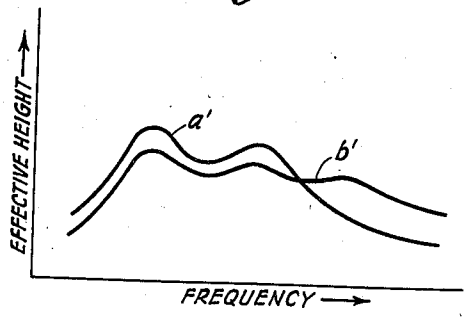
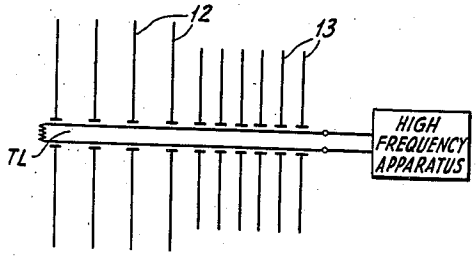


Fig. 3d



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DIRECTIVE ANTENNA

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11 Claims. (Cl. 250—33)

This invention relates to directive antennas and more particularly to directive receiving antennas of the so-called "fishbone" array.

The directive "fishbone" receiving array now used in commercial radio reception consists of a number of parallel, equally spaced, similar size collector wires or doublets connected through small coupling capacitors to a common transmission line which conducts the signal to the radio receiver. The length of the collector wires and the size of the coupling condensers are chosen to give maximum received signal for a desired band of frequencies. Such an arrangement is described in U. S. Patent No. 1,821,402, granted September 1, 1931, to Harold O. Peterson. It has been found, however, that this antenna array responds rather markedly to only a relatively small frequency band, so that it is necessary to use several arrays to effectively cover the commercial frequency spectrum.

The present invention provides an improved directive antenna in the form of a "fishbone" array which gives more uniform response over a wide frequency band and thus makes it possible to efficiently receive over a much wider frequency spectrum, so that for a given frequency range to be covered, a smaller number of antenna arrays will be required.

A better understanding of the present invention may be had by referring to the following detailed description which is accompanied by drawing wherein:

Fig. 1 illustrates a known type of antenna in the form of a so-called "fishbone" array;

Fig. 2 is a graph showing curves explanatory of the operation of Fig. 1;

Figs. 3*a*, 3*b*, 3*c* and 3*d* illustrate four different embodiments of the present invention; and

Fig. 4 is a graph showing curves explanatory of the operation of the antennas of the invention.

Referring to Fig. 1, there is shown a directive antenna of known type comprising a two wire transmission line TL to which are coupled transverse doublets 1. The wires of transmission line TL are closely spaced in order to avoid their picking up received energy. One terminal of the transmission line is connected to suitable high frequency apparatus, herein indicated conventionally in box form by the designation "radio receiver." To make the antenna unilateral in directivity, the end of the line TL nearest the desired transmitting station and farthest removed from the radio receiver is closed by a suitable terminating resistance R whose impedance is equal to the surge impedance of the line as loaded by energy collecting doublets 1. Resistance R absorbs energy approaching from the direction of the radio receiver and thereby prevents its reflection back to the receiver.

The energy collecting doublets 1 are preferably untuned and coupled externally to the feeder members through limiting impedances, herein shown preferably in the form of small series condensers 1'. United States Patent No. 1,908,536 describes a type of coupling condenser commonly used in this type of antenna. By loosely coupling the doublets to the transmission line TL in this manner, they have less effect upon the velocity of the wave in the line, and their effect remains small in spite of appreciably large variations in the length of the received waves. Since this type of antenna is well-known in the art, no further description is herein deemed necessary, except perhaps to refer to United States Patent No. 1,821,402, supra, which describes such an arrangement.

Fig. 2 shows various graphs illustrating frequency versus effective height characteristics of an antenna of the type shown in Fig. 1. Graph *a* is the frequency response curve for a "fishbone" antenna having one particular length of doublet wire and value of coupling condenser. Graph *b* shows a similar frequency response curve for a shorter length of doublet, and graph *c* represents a frequency response curve for a still shorter length of doublet.

Referring to Fig. 3*a* which illustrates one embodiment of the present invention, there are shown two sets of doublets 10 and 11 having different lengths, all capacity coupled to the line TL in the same manner as shown in Fig. 1. The doublets 10 and 11, it will be observed, are grouped together in two different lengths.

Fig. 3*b* shows another embodiment of the invention which is quite similar to the system of Fig. 3*a* except that there are here shown a "fishbone" array having groups of doublets of three different lengths, namely 7, 8 and 9. In this embodiment doublets 9 contribute the greater portion of the energy at the lower frequencies, doublets 8 at intermediate frequencies and doublets 7 at the higher frequencies. Now, at the higher frequencies where doublets 7 are contributing the greater portion of the signal energy doublets 9 may load the transmission line TL quite heavily. Therefore, it is advantageous to place these doublets ahead of doublet 7 so that the useful signal energy passing from 7 to the transmission line and thence to the receiver is not absorbed by the loading of doublets 9.

Fig. 3c illustrates a still further embodiment of the invention wherein there is employed a tapered array comprising doublets which taper continuously in length from one end of the antenna to the other.

In Fig. 3d, which illustrates a further embodiment, the spacings between adjacent doublets along the transmission line TL are made greater for the longer doublets 12 than for the shorter ones 13. In this manner there is obtained roughly the same number of doublets per wavelength along the transmission line of the mean operating frequency for those doublets in each group.

Reverting for a moment to the graphs of Fig. 2, it will be evident that each group of collector doublets of a particular length will respond most efficiently to its corresponding band of frequencies, so that the combination of two or more of such groups, as represented by curves *a*, *b* and *c*, will give the result of high response for a wider frequency band.

Figs. 3a, 3b and 3c employ this principle and give the result of high response for a wider frequency band, as shown in the two curves *a'* and *b'* of Fig. 4, which represent respectively the arrangements of Figs. 3a and 3b. The use of a tapered array such as shown in Fig. 3c results in a more uniform response over the desired frequency spectrum.

The capacitors through which the doublets of Figs. 3a, 3b, 3c and 3d are coupled to line TL need not be all of equal capacitance but rather the capacitance should be properly proportioned for each length of doublet to give optimum transfer of voltage to the line TL without imposing adverse loading. The method of selecting the desired value of capacitance is well known in the art.

It is to be distinctly understood that the present invention is not limited to the precise arrangements shown and described since various modifications may be made without departing from the spirit and scope of the invention. It should also be understood that although the invention has been described particularly with reference to a receiving system, it is not limited thereto since the antenna may equally well be used for transmitting purposes. Although the doublets have been shown capacitively coupled to the transmission line TL, it should be understood that the "fishbone" type of array is not limited to such manner of coupling, since the doublets may, if desired, be alternatively connected either resistively or directly to the line TL in the same manner as described in United States Patent No. 1,841,402, supra, and the present invention is applicable to any of these or other types of "fishbone" antennae wherein any desired type of coupling is used between doublets and line.

What is claimed is:

1. A directive receiving antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of transverse relatively closely spaced aerial elements of different lengths loosely coupled to said line for enabling communication with waves over a relatively wide frequency band, said antenna being aperiodic for waves of all frequencies in said band.

2. A directive receiving antenna capable of receiving a wide band of frequencies comprising a straight two wire transmission line, a plurality of relatively closely spaced doublets of different lengths externally and loosely coupled to said line transversely, each doublet having two arms which are coupled to different wires of said line, and high frequency apparatus coupled to one end of said line, said antenna being aperiodic for waves of all frequencies in said band.

3. A directive receiving antenna capable of receiving a wide band of frequencies comprising a two wire transmission line, a plurality of doublets of different lengths externally coupled to said line transversely, each doublet having two arms which are coupled to different wires of said line, high frequency apparatus coupled to one end of said line, and a resistance substantially equal to the surge impedance of said line as loaded by said doublets coupled to the other end thereof, said doublets having lengths which decrease from the end at which said resistance is located toward said high frequency apparatus, said antenna being aperiodic for waves of all frequencies in said band.

4. A directive antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of transverse aerial elements of different lengths coupled to said line for enabling communication with waves over a relatively wide frequency band, each of said aerial elements comprising a pair of arms capacitively coupled externally to said line, there being a group of aerial elements for each different length, said antenna being aperiodic for waves of all frequencies in said band.

5. A directive antenna for communication over a band of frequencies comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of relatively closely spaced aerial elements continuously decreasing in length toward said high frequency apparatus, said elements being loosely coupled to said line, said antenna being aperiodic for waves of all frequencies in said band.

6. A directive receiving antenna capable of receiving a wide band of frequencies comprising a relatively closely spaced straight two wire transmission line, a plurality of energy pick-up doublets coupled transversely and externally to said line, each doublet having two arms which are coupled capacitively to different wires of said line, high frequency apparatus coupled to one end of said line and a damping resistance coupled to the other end of said line, said doublets being divided into groups having different lengths of conductors, said antenna being aperiodic for waves of all frequencies in said band.

7. A directive receiving antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of aerial elements, all of different lengths, continuously tapering in length from one end of said antenna to the other and coupled capacitively to said line, the longest aerial element being located farthest from said high frequency apparatus, said antenna being aperiodic over a wide band of frequencies.

8. A directive antenna comprising a straight transmission line, high frequency apparatus coupled to said line, and a plurality of transverse relatively closely spaced aerial elements of different lengths loosely coupled to said line for enabling communication with waves over a relatively wide frequency band, said antenna being aperiodic for waves of all frequencies in said band.

9. A directive antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of relatively closely spaced aerial elements of different lengths coupled

to said line through limiting impedances for enabling communication with waves over a relatively wide frequency band, said antenna being aperiodic for waves of all frequencies in said band.

10. A directive antenna comprising a transmission line, high frequency translating apparatus coupled to said line at one end, and three groups of transverse aerial elements of different lengths coupled to said line along the length thereof for enabling communication with waves over a relatively wide frequency band, the aerial elements in each group being of the same length, each of said aerial elements comprising a doublet having a pair of arms capacitively coupled externally to said line, said doublets increasing in size from the end of the line to which the translating apparatus is coupled, said antenna being aperiodic for waves of all frequencies in said band.

11. A directive antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of groups of aerial elements of different lengths coupled to said line along the length thereof, the spacings between adjacent elements for the longer elements being greater than for the shorter elements, said antenna being aperiodic over a wide band of frequencies.

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