July 2, 1963 O. A. TIIKKAINEN 3,096,518

LOOP ANTENNA WITH IMPEDANCE MATCHING

Filed June 20, 1960 3 Sheets-Sheet 1

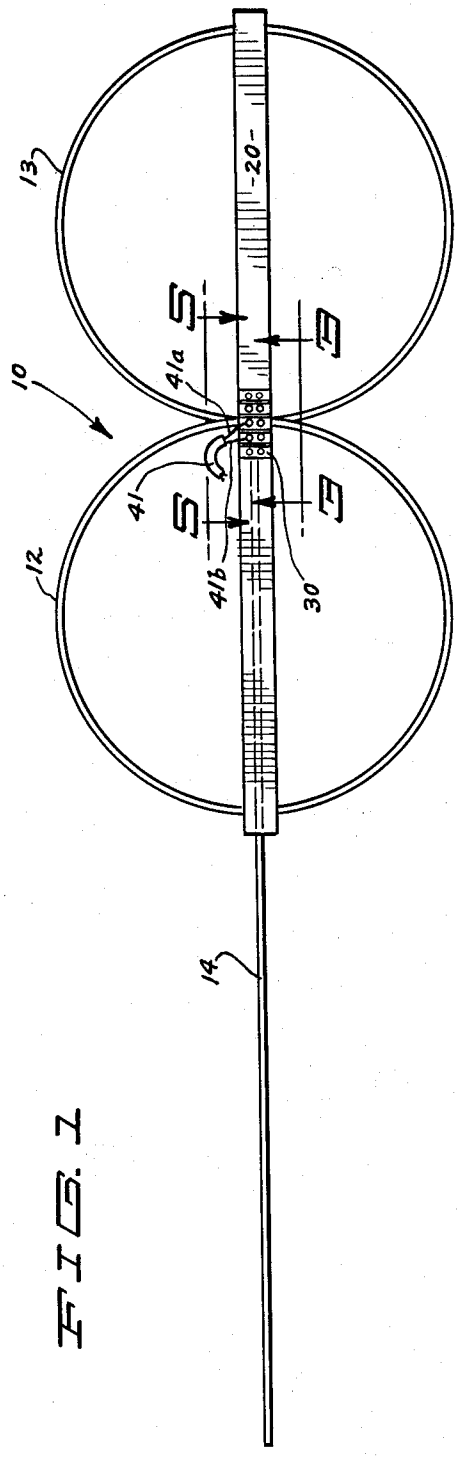


FIG. 1

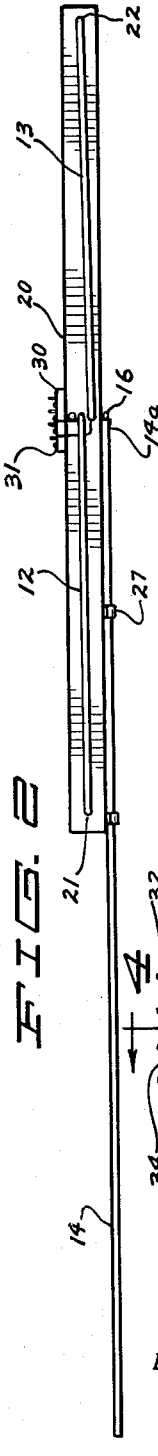


FIG. 2

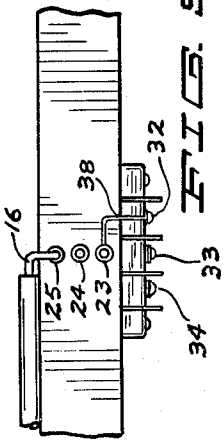


FIG. 5

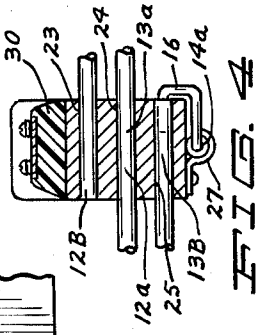


FIG. 4

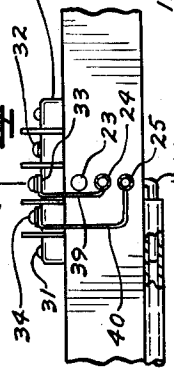


FIG. 3

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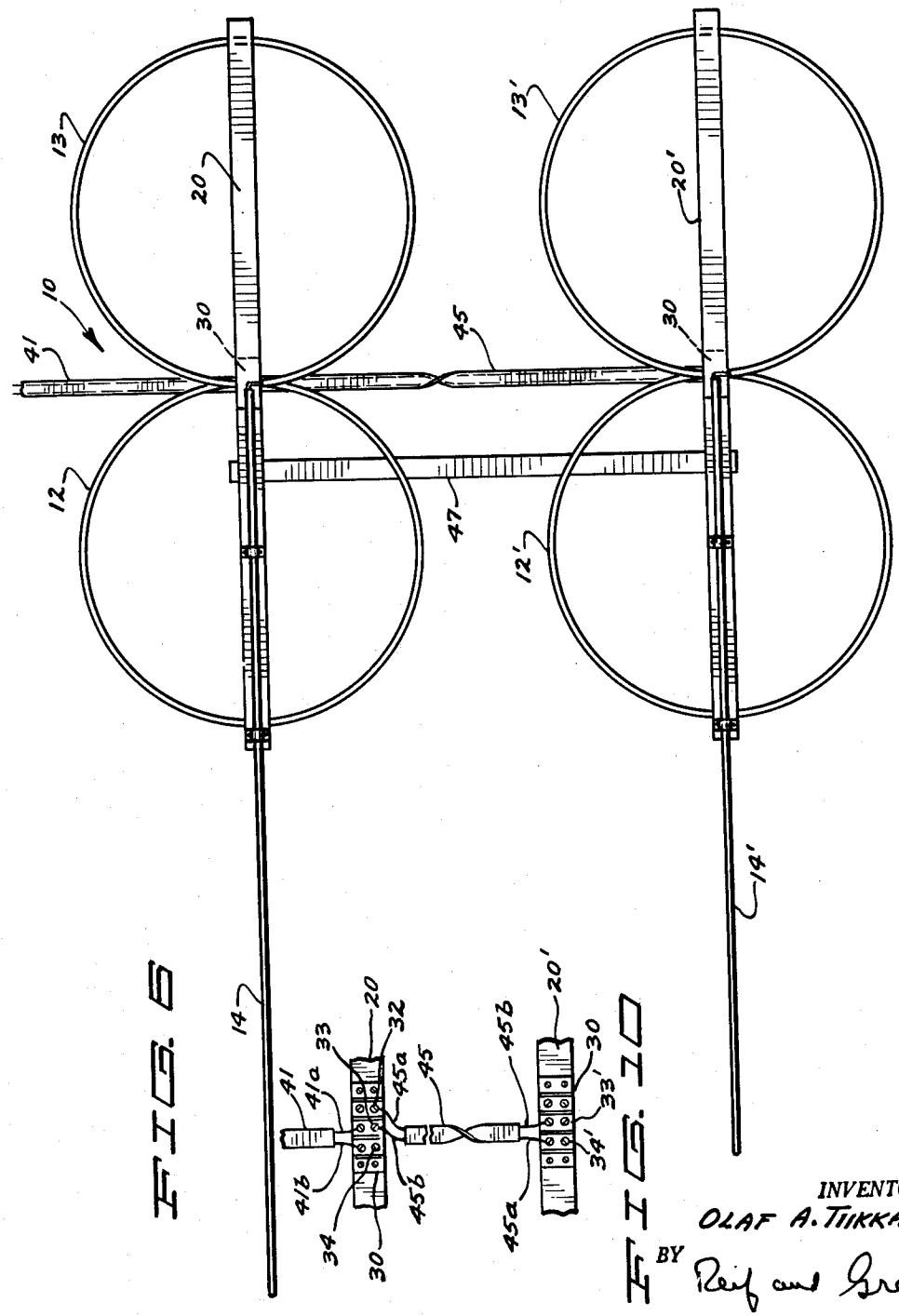


FIG. 6




FIG. 7

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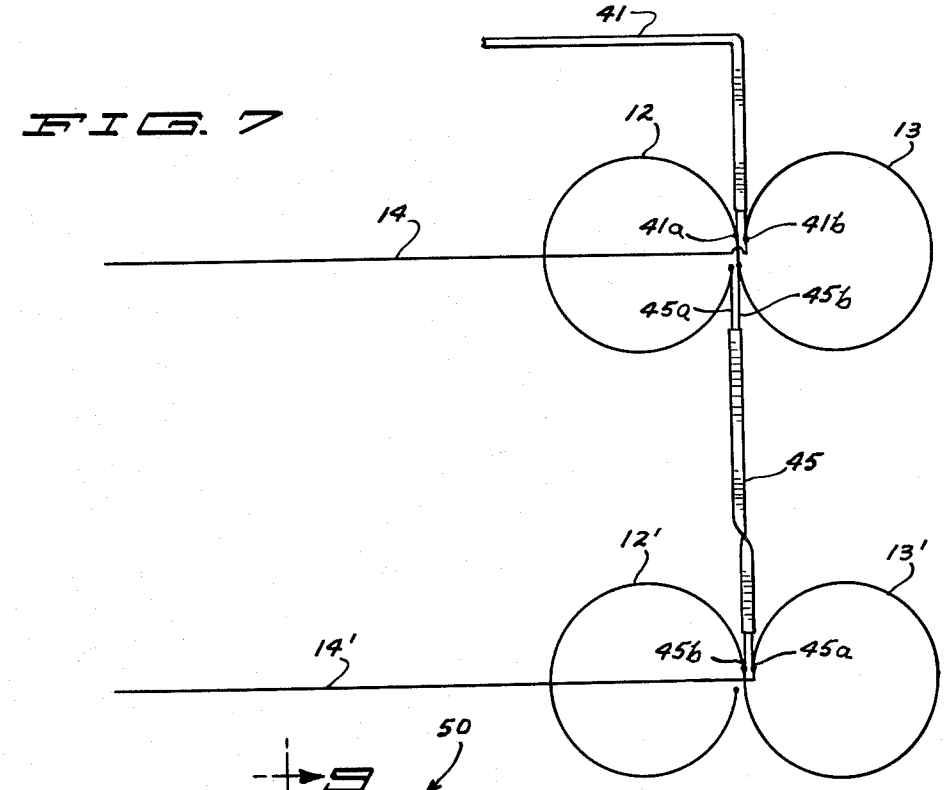
FIG. 7



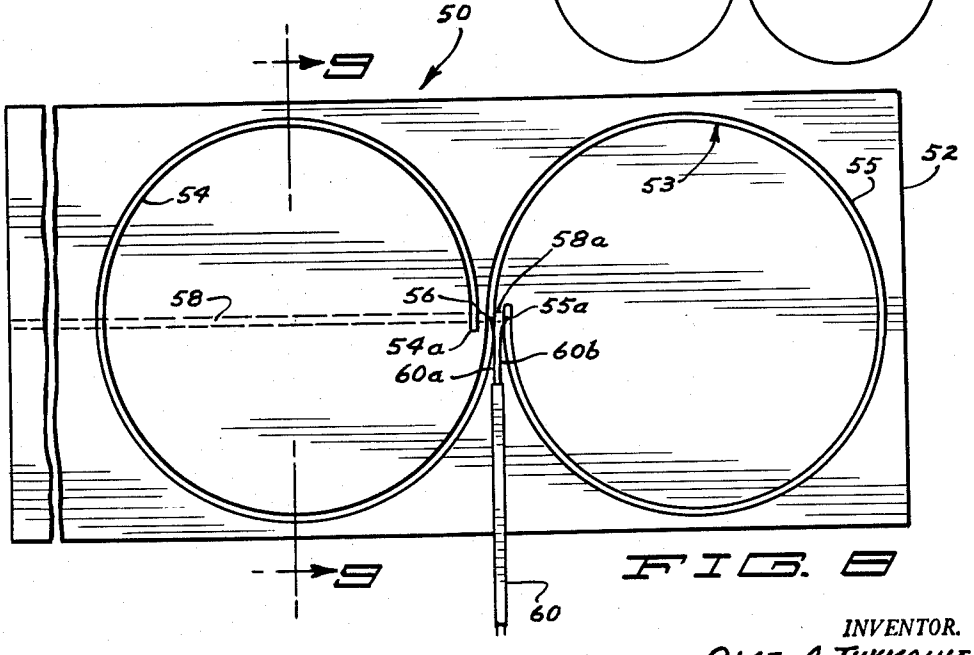
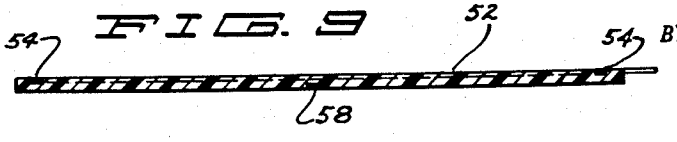




FIG. 8

FIG. 9

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3,096,518

# LOOP ANTENNA WITH IMPEDANCE MATCHING

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12 Claims. (Cl. 343—742)

This invention relates to a relatively small and compact antenna system for indoor installation and designed to provide a performance which may be considered to be an improvement over that of commonly used out-of-door antennas, such as roof installations. Reference is had particularly to home television reception.

Although peculiarily well adapted for home use, applicant's antenna system is designed for high frequency or modulated carrier signals that are horizontally polarized. Within a local reception area and even within the extent of a fringe area, applicant's antenna system is substantially nondirectional and provides very satisfactory picture quality over the entire operative band of megacycles in the very high frequency range.

It is an object of this invention therefore to provide an antenna system which is of a simple and relatively compact construction for interior installation and which will provide a superior performance in comparison with commonly used out-of-doors antenna systems.

It is another object of this invention to provide an antenna system such as may be installed by suspension from a rafter in an attic or air space area, or which may be formed as on a flat plate and of ribbon material, or as a printed circuit on a plate member for interior installation as under a rug or carpet surface.

It is also an object of this invention to provide a horizontally disposed antenna comprised of a double coplanar loop element construction with a straight element in connection therewith, and said elements being respectively formed to be in length one-quarter of the operating wave or signal frequency.

It is a further object of this invention in view of the preceding object to provide for the connection of the loop and straight elements at certain points on the antenna representing the highest points of signal voltage induced in the elements by horizontally polarized transmission.

It is still another object of this invention to provide for a very high frequency antenna system particularly adapted for the transmission and reception of television signals and which is characterized by uniform high gain reception characteristics over a wide band of frequencies and which is highly responsive to horizontally polarized signals.

More specifically it is an object of this invention to provide an antenna system comprising a pair of horizontally disposed adjacent substantially coplanar loop elements having a pair of adjacent joined ends and a pair of spaced free ends and a straight element in a plane parallel to the plane of said loop elements extending in the direction of the longitudinal axis of the figure formed by said double loop elements and being connected to the free end of the other of said loop elements.

It is also an object of this invention to provide a pair of the antenna systems such as set forth in the preceding object, said pair of systems being coplanar, horizontally disposed and laterally spaced apart.

These and other objects and advantages of the invention will be fully set forth in the following description made in connection with the accompanying drawings in which like reference characters refer to similar parts throughout the several views and in which:

FIG. 1 is a top plan view of applicant's novel structure;

FIG. 2 is a view in side elevation;

FIG. 3 is a view in vertical section on an enlarged scale taken on line 3—3 of FIG. 1 as indicated by the arrows;



FIG. 4 is a view in vertical section taken on line 4—4 of FIG. 3 as indicated by the arrows;

FIG. 5 is a view in vertical section on an enlarged scale taken on line 5—5 of FIG. 1 as indicated by the arrows;

FIG. 6 is a bottom plan view of a modification of applicant's structure;

FIG. 7 is a schematic diagram on a reduced scale of applicant's structure as indicated in FIG. 6;

FIG. 8 is a top plan broken view of a further modification of applicant's structure;

FIG. 9 is a view in vertical transverse section taken on line 9—9 of FIG. 8 as indicated by the arrows; and

FIG. 10 is a fragmentary plan view showing the terminal strips used in connection with structure shown in FIG. 6.

Referring to the drawings, and particularly to FIGS. 1–5, an antenna **10** comprising a basic unit of applicant's antenna system is shown. Said antenna is particularly adapted for the reception and transmission of very high frequencies in connection with television.

Said antenna **10** is here shown comprising loop elements **12** and **13** and a straight element **14**, each of which has a length equal to one-fourth of the length of the operating wave or signal frequency. Said elements may be formed of various suitable materials and are here indicated as being formed of 3/16 inch copper tubing. Said elements are horizontally disposed in operating position. Said loop elements are substantially coplanar. Said loop elements may be variously formed but are here indicated as being formed of an integral piece of copper tubular material having at their point of juncture what are indicated as being joined end portions **12***a* and **13***a* and having spaced free end portions **12***b* and **13***b*.

Said free ends may be disposed in a horizontal plane, but are here shown to be in vertical alignment. Said free ends are insulated from said joined ends and from one another. It has been found that said free ends positioned at either side of said joined ends may be either vertically or horizontally aligned with respect to the plane of said loop elements so long as they are not spaced further away from said joined ends than the width of the antenna element. With this relationship a desirable balanced capacitative effect is secured.

Said element **13** will be referred to as the front element, and element **12** as the rear element.

The straight element **14** is disposed in a plane substantially parallel to the plane of said loop elements **12** and **13** and extends in the direction of the longitudinal axis of the figure formed by said loop elements **12** and **13** and is in vertical alignment therewith. Said straight element underlies one of said loop elements, here being the loop element **12**, and extends outwardly thereof and has its inner end **14***a* connected to and made integral with said free end **13***b* by a connecting member or coupling **16**.

Said elements **12—14** may be supported in various suitable ways. In the embodiment of the invention here disclosed, a supporting member **20** is shown as a substantially rigid elongated non-conductive member of relatively small transverse dimension substantially parallelepiped in form. Said member is preferably of a length somewhat greater than the distance between diametrically opposed remote points of said loop elements. Formed in said member **20** are a plurality of transverse apertures consisting of apertures **21** and **22** adjacent either end of said member and the apertures **23—25** disposed centrally of said member in vertical alignment as indicated in FIGS. 3 and 5. The remote diametrically spaced portions of said loop elements will be disposed in said apertures **21** and **22** and the joined ends of said loop elements will be disposed in said aperture **24**. Said free ends **12***b* and **13***b* will be respectively disposed in said apertures **23**

and 25. Said apertures are here spaced to be 3/32 inch apart.

Thus said loop elements are very nicely held in position on a conveniently handled supporting member which lends itself to ready mounting or installation in a desirable place.

Said straight element is insulated from said loop element 12 by being secured to the underside of said member 20, as by U brackets 27, as indicated in FIG. 2.

Mounted centrally on the upper surface of said member 20 is a terminal strip 30 secured by screws 31 and having pairs of contacts 32, 33 and 34.

Said free end 12*b* is connected to the contact 32 by a connector 38. Said joined end portions 12*a* and 13*a* are connected to the contact 33 by a connector 39, and the end portion 13*b* to which said straight element is joined is connected to the contact 34 by a connector 40.

A 300 ohm impedance transmission line 41 is preferably used having its leads 41*a* and 41*b* respectively connected to said contacts 33 and 34.

Applicant's antenna system as is obvious from the above description is of small size and compact in arrangement requiring an area of only approximately 12 x 48 inches in plan and less than two inches in depth. An outdoor antenna used for the same purpose as applicant's would require an area of five or six feet in height and a width and depth of approximately the same distance. Applicant's antenna is intended for use within an area not exceeding the extent of a fringe area and within this proximity to transmitting stations, it is substantially non-directional. A high gain response is received resulting in a picture of very good quality.

Applicant's straight element 14 in combination with the loop elements 12 and 13 acts as a matching stub for better impedance and results in signal strength and picture or image quality much superior to what would be otherwise received. Applicant estimates from experiments made that the straight element added to the loop elements as indicated, results in a performance better by approximately 50 percent over what would result from the use of loop elements alone, which without said straight element are not unlike figure 8 types of antenna in use.

It is important that the free ends of loop elements 12 and 13 be positioned as indicated above or the signal strength will be adversely affected and the voltage will tend to get out of phase.

With reference to FIGS. 6, 7 and 10, a modification of applicant's antenna system is shown wherein the antenna 10 is combined with a second and identical antenna 10'. Said antenna 10' therefore is not shown in as specific detail as said antenna 10 but the portions thereof which are indicated are indicated by characters corresponding to characters indicating like portions of antenna 10 with the difference that a prime is added to the characters of antenna 10'.

The antenna 10' will be connected to said antenna 10 by means of the 300 ohm impedance twin lead line 45 which is preferably of a length between that of 1/8 to 1/4 of the operating wave length with the contacts 32—34' and 33—33' being respectively connected by the leads 45*a* and 45*b* of said transmission line 45. Thus the free end portion 12*b* is connected to the end portion 13'*b* of the loop element 13' although this detail is not shown. This has been found to be a preferred hook-up. Said lead line 45 is indicated as being twisted centrally thereof. Said members 20 and 20' will be suitably connected by a supporting frame member 47.

The double antenna array comprised of said antennas 10 and 10' has greater signal strength than said single antenna unit 10 and is capable of greater signal strength in fringe areas. In comparison to this double antenna array, said single antenna 10 provides very satisfactory reception within local reception areas.

For maximum signal strength, said double antenna array is positioned with the straight elements 14 and 14'



extending in a direction away from the desired transmitting station and in a position such that the central longitudinal axis thereof and the line of direction between the receiving point and the transmitting station are not angularly displaced by more than 45 degrees. The directive pattern of reception of said array is maximum over approximately a 90 degree quadrant with the bisector of the quadrant extending in a direction coinciding with the central longitudinal axis of said array. This array has been found to provide excellent picture quality in fringe areas.

With reference to FIGS. 8 and 9, a modification is shown comprising an antenna 50 which is similar in detail to said antenna 10.

Said antenna 50 comprises a flat rectangular plate member 52 formed of a suitable rigid insulating material. Mounted on said plate member 52 and recessed therein, as indicated in FIG. 9, is a substantially flat ribbon-like strip of highly conductive material 53 forming loop elements 54 and 55, with said elements being joined at the point indicated by the character 56. Said loop elements 54 and 55 have free end portions 54*a* and 55*a* respectively terminating at either side of said point 56, as indicated in FIG. 8. A straight element 58 is recessed in the underside of said plate member 52, as indicated in FIG. 9, and is positioned to extend in a direction underlying diametrically said loop 54 and be positioned to be in vertical alignment with the longitudinal axis of the figure formed by said loops 54 and 55. Said straight element 58 is made integral at its inner end 58*a* with said free end portion 55*a*.

Said free end portions by being recessed within said plate member 52 are adequately insulated from one another and from the portion 56 of the strip member 53.

A transmission line 60 will be recessed in the upper surface of said plate member 52. Said transmission line 60 is preferably formed of a 300 ohm impedance twin lead transmission line. Said transmission line will be suitably connected to make contact with the points or portions 56 and 55*a*.

Said antenna structure 50 although formed here of a flat ribbon-like material, may be made into a substantially thinner antenna structure by having printed loop and straight elements formed in a plate supporting member. This construction is obvious from what is shown in connection with said antenna structure 50.

Said antenna 50 may be positioned as under a rug or carpet surface without its presence being apparent. It has been found in practice to provide in local areas a satisfactory quality of reception though not of the same excellent quality as results from the use of the tubular antenna 10. If desired for an improved quality of reception, a pair of antennas such as antenna 50 may be coupled in the manner as indicated in FIGS. 6 and 7.

Thus it is seen that the applicant has provided a very compact and simply constructed antenna which is very easy to mount or install in a home and which as has been indicated may be installed by even being placed under a rug. Applicant's antenna structure has been found to be unusually successful in operation and a substantial improvement over the commonly used outdoor type of television antenna.

It will of course be understood that various changes may be made in the form, details, arrangement and proportions of the parts, without departing from the scope of applicant's invention, which, generally stated, consists in a device capable of carrying out the objects above set forth, in the parts and combinations of parts disclosed and defined in the appended claims.

What is claimed is:

1. A substantially non-directional antenna system comprising a pair of adjacent loop elements and a straight element each being approximately one-fourth of the length of the operating wave, said loop elements being horizontally disposed in substantially a coplanar relation and

having a point of juncture and each having a free end, said straight element extending across one of said loop elements along the longitudinal axis of the figure formed by said loop elements, means insulating said straight element from said loop element, and said straight element being integral with the free end of the other of said loop elements.

2. An antenna system comprising a pair of adjacent horizontally disposed loop elements and a straight element, said elements being formed of flat strip-like material, said loop elements being substantially coplanar and said straight element being in a plane parallel to the plane of said loop elements, a flat insulating plate being disposed between said loop elements and said straight element, said loop elements having a pair of joined ends and a pair of free ends, said straight element extending in a direction across one of said loop elements and being integral with the free end of the other of said loop elements.

3. The structure set forth in claim 2, said loop and straight elements respectively having a length one-fourth of the length of an operating wave.

4. An antenna system comprising a pair of adjacent horizontally disposed loop elements, an elongated insulating bar-like member having said loop elements disposed therethrough, said loop elements being substantially coplanar in tandem relation, a straight element mounted along an outer side of said insulating member insulated from said loop elements, said straight element extending in the direction of the longitudinal axis of the figure formed by said loop elements and diametrically across one of said loop elements in a plane parallel to the plane of said loop elements, said loop elements having a pair of joined adjacent ends and a pair of remote free ends, said straight element being integral with the free end of the other of said loop elements.

5. An antenna system comprising a flat plate-like horizontally disposed insulating member, a pair of adjacent loop elements recessed in said plate-like member, said loop elements having joined adjacent ends and free remote ends, a straight element recessed in said plate-like member and insulated from said loop elements, said straight element extending in the direction of the longitudinal axis of the figure formed by said loop elements and extending across one of said loop elements and having one end integral with the free end of the other of said loop elements.

6. An antenna system comprising a pair of adjacent coplanar front and rear loop elements having joined adjacent ends and remote free ends, a straight element extending across the rear of said loop elements in the direction of the longitudinal axis of the figure formed by said loop elements and being in a plane parallel to the plane of said loop elements and said straight element having one end integral with the free end of the front of said loop elements.

7. The structure set forth in claim 6, said loop and straight elements each having a length one-fourth of the length of the operating wave.

8. An antenna system comprising a member of conductive material of small transverse dimension having a length substantially three-fourths of the length of an operating wave, said member being formed into a pair of tandem substantially coplanar loop elements having an integral juncture point with one loop having a free end adjacent thereto, the remaining portion of said member being in the form of a straight element extending across said loop element having said free end parallel thereto and insulated therefrom and extending in the direction of the longitudinal axis of the figure formed by said loop elements and being integral with the other of said loop elements as a continuation of the end portion thereof.

9. A substantially non-directional antenna system comprising a pair of adjacent loop elements defining substantially a figure **8** disposed in substantially a common horizontal plane, a straight element extending in the direction of the longitudinal axis of the figure defined by said loop elements and across one of said loop elements and forming a continuation of the other of said loop elements, a non-conductive member having said loop elements mounted thereon and having said straight element secured thereto insulated from said loop elements.

10. A substantially non-directional antenna system comprising a pair of substantially identical adjacent loop elements having a juncture point and each having a free end portion, said loop elements being substantially coplanar and horizontally disposed, an insulating member having said loop elements mounted thereon, a straight element extending across only one of said loop elements in a plane parallel to the plane of said one of said loop elements along the longitudinal axis of the figure defined by said loop elements and being insulated from said one of said loop elements by said insulating member and being integral with the free end of the other of said loop elements.

11. A substantially non-directional antenna system comprising a pair of adjacent tandem loop elements disposed in substantially a common horizontal plane having a point of juncture and each having a free end, a straight element extending diametrically of one of said loop elements parallel thereto and being integral at one end with the free end of the other of said loop elements, and a rod-like insulating member carrying said loop elements and said straight element and insulating said straight element from said loop elements.

12. A substantially non-directional antenna system comprising a pair of substantially identical adjacent tandem loop elements disposed in substantially a common horizontal plane having a point of juncture and each having a free end, a straight element extending across one of said loop elements, means insulating said straight element from said one of said loop elements, said straight element extending along the longitudinal axis of the figure formed by said loop elements and being integral with the free end of the other of said loop elements.

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