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[54] **ROLLABLE SLOT ANTENNA**  
**5 Claims, 10 Drawing Figs.**

[52] **U.S. Cl.**..... **343/770,**  
343/834, 343/881, 343/915

[51] **Int. Cl.**..... **H01q 13/10**

[50] **Field of Search**..... **343/700**  
(A), 770, 833, 834, 908, 915, 702, 767, 720, 881

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**ABSTRACT:** An antenna having a rectangular sheet of metal foil with parallel spaced slots formed therein. The slotted sheet serves as a radiator operating in the UHF band. The metal sheet is enclosed between overlying and underlying plastic sheets which are heat sealed to the metal sheet. The composite laminate structure is flexible thus permitting the rolling thereof.

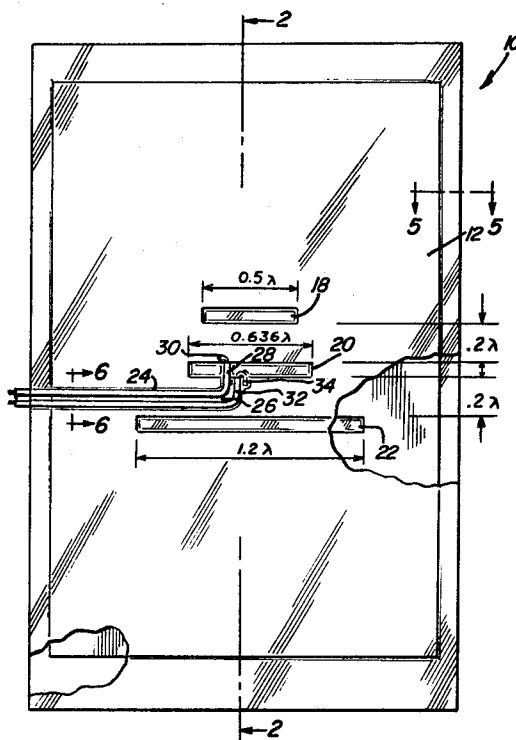


Fig. 1

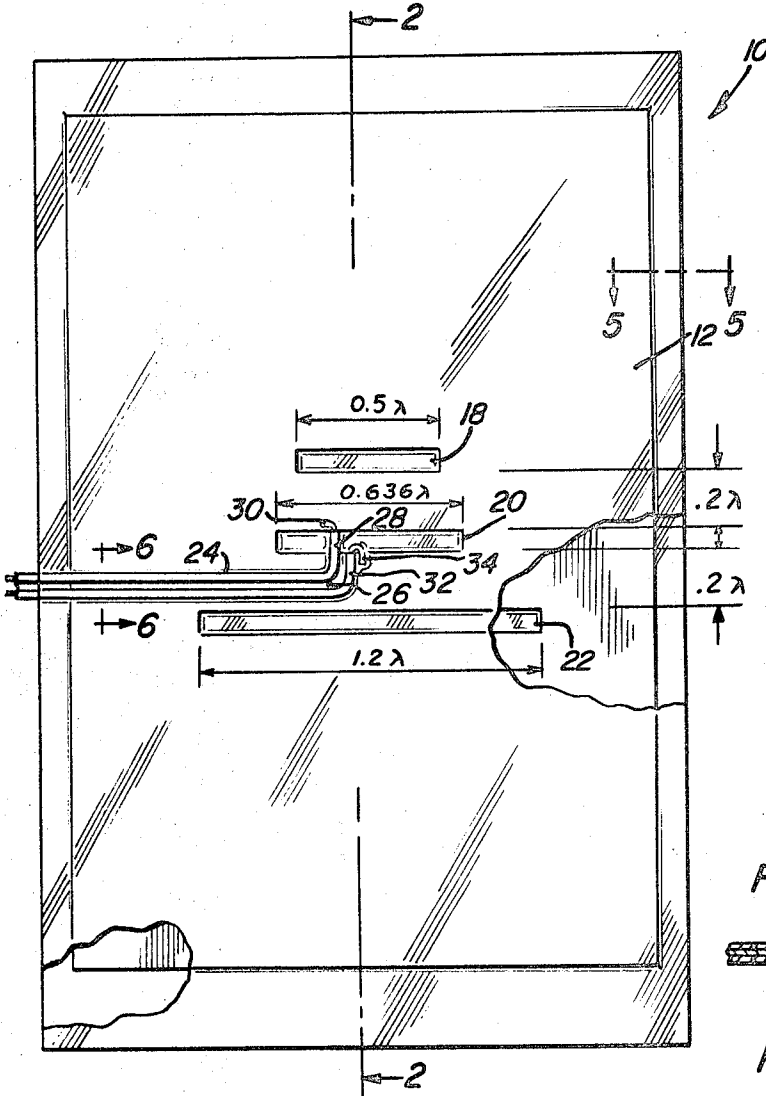


Fig. 2

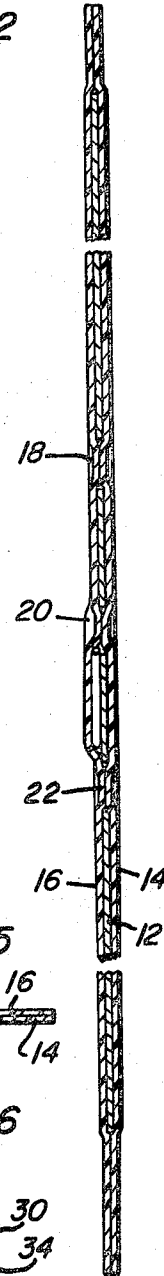


Fig. 5

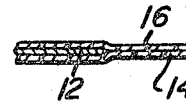


Fig. 6

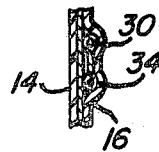


Fig. 3

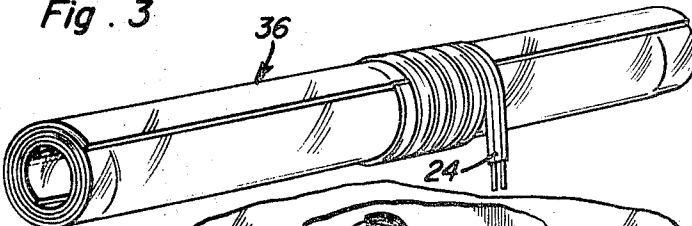
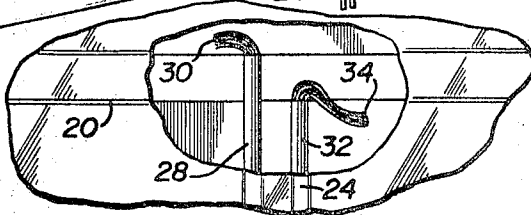
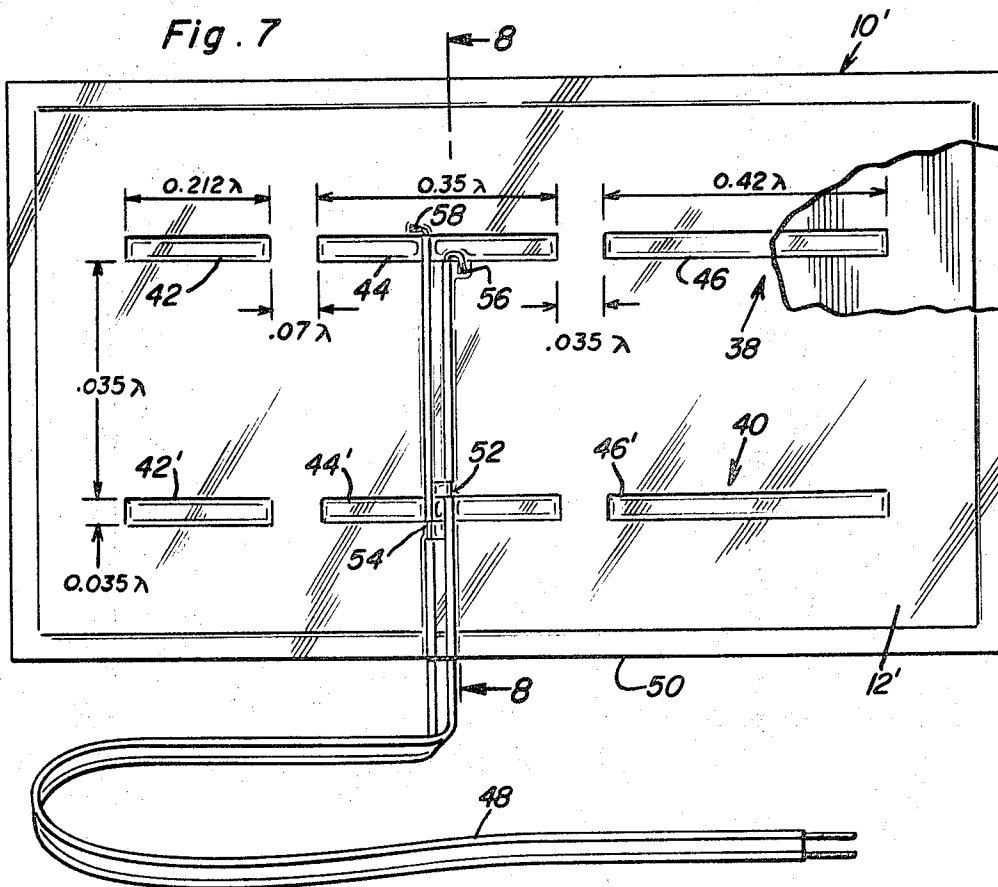
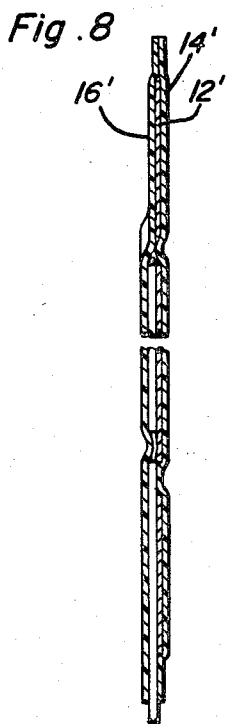
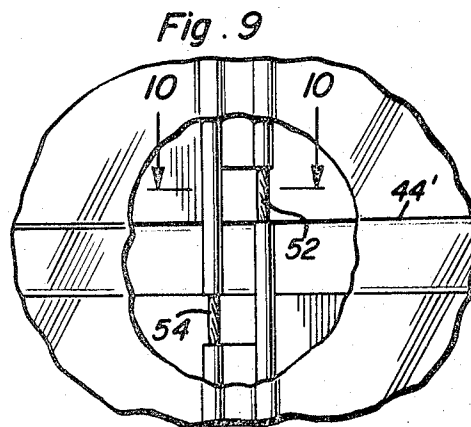
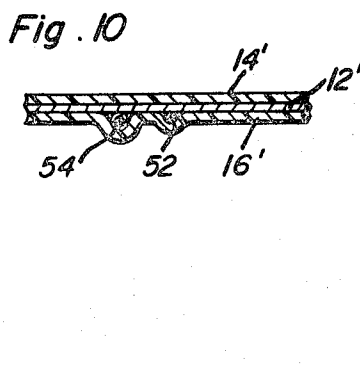


Fig. 4



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## ROLLABLE SLOT ANTENNA

The present invention relates to antenna structures and more particularly to slot antennas.

Conventional antenna structures comprise metallic radiating elements contoured in different shapes to effect preselected radiation patterns. Antennas associated with television receivers are usually permanently mounted on an exterior building structure where they are not amenable to easy removal or maintenance when desired. Further, such antennas detract from the aesthetic appearance of the mounting building structure. Certain antenna assemblies connected to conventional television receivers include telescoping or collapsing antennas referred to as "rabbit ears." The performance of this type of antenna construction leaves something to be desired when operating in the UHF band. Most conventional television receivers now come equipped with a loop antenna which enables satisfactory reception of UHF signals. However, the latter antenna construction generally requires the restrictive mounting thereof in close proximity to the television receiver.

The present invention includes two principal embodiments of a slot antenna. A theoretical analysis of this type of antenna is disclosed in chapter 5 of the book entitled "Antenna Analysis" by Edward A. Wolff, published by John Wiley & Sons, 1966.

The novelty of the present invention resides in the utilization of a slotted foil radiating plane sandwiched between flexible insulating sheets which permit the rolling of the antenna into a compact package when not in use. The preferred embodiment operates satisfactorily in the television UHF band and is amenable to mounting on a flat surface such as the rear panel of a television cabinet. In such an installation, the antenna is hidden from view. Thus, the present invention offers a greater degree of installation flexibility than prior art devices.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIG. 1 is a top plan view of the first antenna embodiment.

FIG. 2 is a longitudinal sectional view taken along a plane passing through section line 2-2 of the antenna structure shown in FIG. 1.

FIG. 3 is a perspective view illustrating the invention in a rolled condition.

FIG. 4 is a partial cutaway view illustrating the connection of a twin lead wire to the radiating surface of the antenna.

FIG. 5 is a partial sectional view illustrating the disposition of a radiating sheet between overlying plastic sheets, in the vicinity of a slit formed within the radiating sheet.

FIG. 6 is a partial sectional view taken along a plane passing through section line 6-6 of FIG. 1 illustrating the disposition of a twin lead wire within the composite laminate structure of the first embodiment.

FIG. 7 is a top plan view of the second embodiment of the present invention.

FIG. 8 is a transverse sectional view taken along a plane passing through section line 8-8 shown in FIG. 7.

FIG. 9 is a partial cutaway view illustrating the connection of a twin lead to the antenna plane of the second embodiment.

FIG. 10 is a transverse sectional view taken along a plane passing through section line 10-10 in FIG. 9.

Referring specifically to the drawings, a first embodiment generally denoted by reference numeral 10 is shown in FIG. 1. The antenna includes a planar member 12 fabricated from a sheet of metal foil such as aluminum, tin, or the like. The sheet is generally characterized as being rectangular in shape, and is enclosed between two parallel spaced plastic sheets 14 and 16 as shown in FIGS. 2 and 5 having peripheral borders extending somewhat beyond the edge of the antenna plane. The borders permit the insertion of fasteners therethrough to permit the mounting of the antenna to a surface.

For purposes of illustration, the following description will be directed to an antenna having a slotted configuration specially adapted for the tuning of stations in the UHF band.

A first rectangular slot is formed in the central portion of the antenna plane and is denoted by reference numeral 18. The slot is disposed transversely of the antenna plane and is symmetrically disposed with respect to a longitudinal axis intersecting the geometric center of member 12. A second rectangular slot 20 is positioned in spaced relation to the first slot 18, the second slot having a greater length than the first slot. The first and second slots have their median points in longitudinal alignment. A third rectangular slot 22 is formed in spaced parallel relation to the second mentioned slot 20. The third slot has a median point which is in longitudinal alignment with the previously mentioned rectangular slots 18 and 20. Thus, as will be noted, the three slots are mutually parallel spaced and symmetrically disposed with respect to a longitudinal axis intersecting the geometric center of the foil sheet 12.

The slot configuration shown in FIG. 1 exhibits the characteristics of a Yagi antenna. More specifically, a signal conducting lead could be connected to the periphery of slot 20 whereby that slot would become a driven element. In this respect, slots 18 and 22 may serve as parasitic elements with the slot 18 serving as a director and the slot 22 serving as a reflector.

Signal communication between auxiliary equipment and the antenna plane 12 is achieved by connecting a lead or cable between the equipment and the antenna. As seen in FIG. 1, a typical cable in the form of twin lead wire 24 has a first end portion transversely positioned against the antenna plane, the lead extending inwardly from a lateral edge of the antenna, the antenna connecting end portion extending inwardly of the antenna plane between slots 20 and 22. In actual fabrication of the antenna, the conductor separating strip 26 is foreshortened at the inward end thereof so that an insulated conductor end 28 may be transversely positioned across slot 20. The end of the lead is stripped at 30 so that electrical contact occurs between lead 28 and the edge portion of slot 20 that is closer to slot 18. In a similar manner, lead 32 is stripped at the end thereof as indicated by 34. The latter mentioned stripped portion is retained in engaging contact with the metallic antenna plane 12 at the edge portion of slot 20 adjacent slot 22. Thus, the twin leads are electrically connected to opposite edge portions of slot 20 as clearly illustrated in FIG. 4. The leads are held in place by the lead wire 24 embedded between the plastic sheets 14 and 16.

Reference is made to FIG. 1 wherein typical dimensions for the slots are shown. These dimensions are designed for reception in the UHF band, and more particularly in the television UHF band. Of course, by varying the relative dimensions of the slots, the operating band of the antenna may be varied.

In fabrication of antenna 10, the antenna foil sheet or plane is sandwiched between the plastic sheets 14 and 16. Next, the antenna wire 24 is positioned so that electrical contact is made with the antenna plane at points hereinbefore mentioned. The relative position of the plastic sheets 14 and 16 are maintained to sandwich the antenna plane 12 and the antenna wire 24 together. The wire and antenna sheet are sealed between the plastic sheets 14 and 16 by means of conventional heat treatment. Thus, the finished product results in a weatherproof, rugged antenna construction. It will be noted that the combination of the antenna sheet foil and plastic sheets, fabricated from pliable materials, permits the rolling of the antenna into a compact package as indicated by 36 in FIG. 3. The antenna wire 24 may then be wrapped around the rolled antenna to conveniently minimize the space required for the storage of the antenna when not in use.

In summarizing the first embodiment of the present invention, the antenna may be considered as including a beam of three elements. The polarization of the pattern radiated depends on the orientation of the antenna plane and may be likened to the polarization characteristics of a dipole. The gain

of the embodiment illustrated in FIG. 1 is in the order of 5 db. Concerning the power handling capability of the present invention, the antenna can operate in the range of milliwatts to kilowatts, depending on the thickness of the foil. If large power radiation is desired, the antenna plane can be fabricated in the form of a hollow channel through which water can circulate.

The impedance of the present antenna can be made to match any impedance from 0 to 500 ohms. This factor depends upon the antenna feed. More particularly, the impedance depends upon the position of the conductor end leads 30 and 34 relative to the length of slot 20. The positioning of the conductors also affects the VSWR which typically ranges from 1.5 to 3.0 for broad band operation.

The beam-width per radiation lobe extends to 270° or 300° overall, for the complete antenna. The particular band width depends on the thickness or width of the slots. The illustrated embodiment has a typical front-to-back ratio of 20 db. The frequency coverage of the present antenna depends on the size of the antenna and may vary from the broadcast band to the gigacycle range. The near-field specification of the antenna depends on the size of the slots and the overall dimension of the antenna plane.

FIG. 7 illustrates the second embodiment of the present invention and is generally indicated by reference numeral 10'. As will be noted, the overall concept of using a foil sheet as an antenna plane and sandwiching the plane between over and underlying plastic sheets is identical to that previously discussed in connection with the first embodiment. Thus, the components 12-16 are identical to both forms and in the case of the second embodiment, these component parts are differentiated by primed numerals.

The second antenna embodiment includes a plurality of slots therein forming a broadside array actually having two slot sets in the array. The first slot set is indicated by reference numeral 38 and the second parallel spaced and identically fashioned set is indicated by 40. For purposes of convenience, the following description will be expressed in terms of the first set 38 which includes a first longitudinally oriented rectangular slot 42 that acts as a parasitic element in the form of a director. A second rectangular slot 44 disposed in longitudinal spaced alignment with the first slot has a greater length than the first slot and is electrically connected to a signal lead as hereinafter described. This slot serves as a driven element. A third rectangular slot 46 is formed adjacent the second slot and in longitudinal alignment therewith. The third slot has a greater length than the second slot 44 and is a parasitic element serving as a reflector. The second set of slots 40 in the array includes three rectangular slots identical to those previously mentioned in connection with set 38, the slots being individually indicated by reference numeral 42', 44' and 46'. Each of the primed slots lies in transverse spaced alignment with an associatively numbered slot of set 38.

A twin lead cable 48 serves to connect the antenna plane with associated electronic gear. A length of the twin lead cable 48 is positioned so that it enters the antenna assembly 10' from lateral edge 50 and overlies a surface of the foil sheet in a manner traversing the median points of both driven element slots 44 and 44'. The twin lead is interposed between the antenna plane surface and the confronting surface of a plastic sheet 16'. More particularly, an intermediate portion of the twin lead is disposed in overlying relation with the antenna plane portion defined between confronting edges of slot 44'. Referring to FIG. 9, the twin lead is stripped along a length immediately adjacent both confronting edges so that electrical contact between the conductor segments 52 and 54 of the twin lead and the confronting edges is effected.

The leading antenna end portion of the twin lead is connected to the antenna plane in a manner identical with that disclosed in connection with the first embodiment. More particularly, the leading end portion of the twin lead is disposed in overlying relation with the foil sheet 12' in the vicinity of slot 44. The leading end of the twin lead is stripped thereby expos-

ing the conductor segments 56 and 58. Conductor segment 56 is retained in juxtaposition with one lateral edge portion of slot 44 while the second conductor segment 58 is retained in juxtaposition with the oppositely disposed lateral edge portion of the slit. The twin lead is illustrated as being connected at mutually aligned median points of slots 44 and 44'. However, this feed arrangement may be varied to alter the antenna VSWR and impedance characteristics. Electrical contact between the twin lead 48 and the antenna plane 12' is retained due to the sealing of the plastic sheets 14' and 16' to the foil sheet 12' by conventional head treatment. In this respect, fabrication of both embodiments is identical.

Referring to FIG. 7, it will be noted that conductor segments 52 and 56 lie along the same conductor of twin lead 48 and the segments are electrically connected to relatively opposite lateral edge portions of slots 44' and 44 respectively. The same relative relation exists with respect to lead conductor segments 54 and 58. Thus, the twin lead is connected to the slots in a transposed feed whereby the polarity of the signal existing at one conductor segment opposes the polarity of the signal existing at the other interconnected conductor segment. This polarity relationship permits the generation of a desired radiation pattern.

Concerning the design and performance specifications of the second embodiment, they are substantially similar to those discussed in connection with the first embodiment. However, the second embodiment is a broadside array type having two antenna radiators in the array. This design feature differs from the Yagi-type design of the first embodiment.

As previously discussed in connection with the first embodiment, the second antenna form shown in FIG. 7 may be similarly rolled to form a scroll as seen in FIG. 3 thereby facilitating the packaging and storing of the antenna when not in use.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

I claim:

1. A slot Yagi-type antenna structure comprising a sheet of metal foil serving as an antenna plane, at least one dielectric sheet juxtaposed on said foil sheet to form a flexible laminate, said foil sheet having a plurality of slots formed therein a signal conducting lead positioned in contacting engagement with said foil sheet at preselected points thereon for completing electrical connections between said foil sheet and said lead, the plurality of slots including a director element slot formed in the sheet, a driven element slot of greater length than the director element slot formed in the sheet and in adjacent spaced relationship to the director element slot, a reflector element slot formed in the sheet having greater length than the driven and director element slots, the reflector element slot being in adjacent spaced relationship to the driven element slot.

2. An antenna structure comprising a sheet of metal foil serving as an antenna plane, two parallel spaced dielectric sheets sandwiching said foil sheet to form a flexible laminate, said foil sheet having a plurality of slots formed therein, and a signal conducting lead positioned in contacting engagement with said foil sheet at preselected points thereon for completing electrical connections between said foil sheet and said lead, three rectangular slots longitudinally and equally spaced in order of increasing slot length, each slot being transversely disposed with respect to a geometric center of the foil, a first end slot serving as a director element, a second intermediate slot serving as a driver element, and a third end slot serving as a reflector element, said lead including two conductors, the conductors being electrically connected to oppositely disposed and transversely extending lateral edge portions of the second intermediate slot.

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3. An antenna structure comprising a sheet of metal foil serving as an antenna plane, two parallel spaced dielectric sheets sandwiching said foil sheet to form a flexible laminate, said foil sheet having a plurality of slots formed therein, and a signal conducting lead positioned in contacting engagement with said foil sheet at preselected points thereon for completing electrical connections between said foil sheet and said lead, two longitudinally extending and parallel spaced slot sets forming a broadside array, each of said sets including three rectangular slots longitudinally spaced in order of increasing slot length, each set comprising a first end slot serving as a director element, a second intermediate slot serving as a driven element, and a third end slot serving as a reflector ele-

ment.

4. The antenna set forth in claim 3 wherein said lead includes two conductors, the ends of said conductors being electrically connected to oppositely disposed edge portions of the intermediate slot associated with the first slot set, intermediate conductor points of said lead conductors being electrically connected to oppositely disposed edge portions of the intermediate slot associated with the second slot set.

5. The antenna set forth in claim 4 wherein the connection of said lead conductors to said slots effectuates transposed feed between the slots.

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