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(54) METHOD AND APPARATUS FOR LAUNCHING A SURFACE WAVE ONTO A SINGLE CONDUCTOR TRANSMISSION LINE

VERFAHREN UND VORRICHTUNG ZUM EINSPEISEN EINER OBERFLÄCHENWELLE AUF EINE EINZELLEITER-ÜBERTRAGUNGSLEITUNG

PROCEDE ET APPAREIL DESTINES A EXCITER UNE ONDE DE SURFACE SUR UNE LIGNE DE TRANSMISSION MONOCONDUCTEUR

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Description**BACKGROUND OF THE INVENTION**5 **Technical Field**

[0001] The present invention relates generally to methods and apparatus for surface wave transmission, and more particularly to an improved method and apparatus for launching a surface wave onto a single wire transmission line.

10 **[0002]** The present invention improves the performance and utility of previous launch devices for converting coaxial mode transmission to and from surface wave mode transmission on a single conductor transmission line. This technology is related to transmission lines made from single conductor line having a thick outer dielectric sheath, an insulated wire, and known as a "Gobau line", "G-line", SWTL (surface wave transmission line), or "singlewire", and is also related to lines made using thinly insulated conductors, as well as completely uninsulated conductors having no outer dielectric sheath at all. It includes conductors fabricated from multiple parallel strands, twisted or untwisted, and either insulated
15 from each other or contacting each other, as well as single solid conductors of elliptical or rectangular cross-section. An example of a Gobau line is disclosed in document US 3509463

Background Art

20 **[0003]** Previous launch devices for single conductor transmission lines have used a simple conical shape structure to excite the surface wave mode onto an insulated single conductor transmission line. In addition to having excess transmission attenuation due to losses in the dielectric insulation, these designs suffer from significant impedance mismatch, unwanted conversion to radiating modes and resultant transmission attenuation of the surface wave mode when a broad range of frequencies is supported, and require both a longer cone and wider cone mouth in order to excite
25 a surface wave mode onto the single conductor. Special effort is also required to mount these previous designs onto the conductor, requiring that the transmission line be broken so that the launch may be threaded onto the line in order to be attached. This presents both mechanical and electrical challenges and limitations to the designer and installer of such a device, particularly if the launch apparatus is to be installed onto a pre-existing single conductor line.

30 **[0004]** The foregoing reflects the current state of the art of which the present inventor is aware. Reference to, and discussion of, this art is intended to aid in discharging Applicant's acknowledged duty of candor in disclosing information that may be relevant to the examination of claims to the present invention. However, it is respectfully submitted that none of the prior art discloses, teaches, suggests, shows, or otherwise renders obvious, either singly or when considered in combination, the invention described and claimed herein.

35 **Disclosure of Invention**

[0005] The present invention provides a method and apparatus for launching a surface wave onto a single conductor transmission line. The inventive apparatus provides launch of a surface wave onto either insulated or uninsulated single conductors making application to a variety of existing lines not only practical, but simpler and more economical. This
40 furthers the use of existing lines, such as high tension power main wires, for surface wave mode transmission of UHF and microwave energy. Previous known references and teachings on the subject have restricted usage to insulated wires.

[0006] The invention includes a flared cone portion constructed of either a continuously curving "horn" or a combination of two or more straight conical sections of different flare angle approximating a curved structure, providing improved impedance match, improved broadband and multiband transmission performance and improved conversion to surface
45 wave mode with a physically smaller horn section when compared to prior, single conical section designs.

[0007] The invention further includes a coaxial adapter portion which adapts conventional coaxial transmission cable to the coaxial transmission line mode which is present at the narrow end of the cone or horn section of the launch, and which can function simultaneously on two different frequency ranges separated by more than an octave.

50 **[0008]** A first embodiment of the invention provides a wire adapter device for contacting the wire conductor which allows for a multiplicity of wire dimensions for either insulated or uninsulated wire. A second embodiment provides a tri-axial wire adapter device enabling non-contacting coupling to a wire.

[0009] The invention also provides a longitudinal slot incorporated into to the flared cone; wire adapter, and coaxial adapter sections of the launch which allows simple and easy placement of the launch onto existing lines, and requires no cutting or threading of those lines for installation. Use of such a slot is not inconsistent with good electrical characteristics
55 of the launch.

[0010] It is therefore an object of the present invention to provide a new and improved surface wave launch apparatus.

[0011] It is another object of the present invention to provide a new and improved surface wave launch adapted for use on insulated or uninsulated single conductors.

[0012] A further object or feature of the present invention is a new and improved flared cone apparatus with improved broadband and multiband transmission performance.

[0013] An even further object of the present invention is to provide a novel coaxial adapter for conventional coaxial transmission cable.

5 [0014] A still further object of the present invention is to provide an improved wire adapter for contacting a wire conductor.

[0015] An additional object of the present invention is to provide an improved method for placement of a surface wave launch on an existing line.

10 [0016] Other novel features which are characteristic of the invention, as to organization and method of operation, together with further objects and advantages thereof will be better understood from the following description considered in connection with the accompanying drawings, in which preferred embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for illustration and description only and is not intended as a definition of the limits of the invention. The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. The invention resides not in any one of these features taken alone, but rather in the particular combination of all of its structures for the functions specified.

15 [0017] There has thus been broadly outlined the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form additional subject matter of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based readily may be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

20 [0018] Further, the purpose of the Abstract is to enable the national Patent Offices and the public generally, and especially the scientists, engineers and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The Abstract is neither intended to define the invention of this application, which is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

25 [0019] Certain terminology and derivations thereof may be used in the following description for convenience in reference only, and will not be limiting. For example, words such as "upward," "downward," "left," and "right" would refer to directions in the drawings to which reference is made unless otherwise stated. Similarly, words such as "inward" and "outward" would refer to directions toward and away from, respectively, the geometric center of a device or area and designated parts thereof. References in the singular tense include the plural, and vice versa, unless otherwise noted.

35 **Brief Description of the Drawings**

[0020] The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawing wherein:

40 [0021] FIG. 1 is a schematic view of a prior art surface wave launch device;

[0022] FIG. 2 is a side elevation cross-sectional view of a first embodiment of an improved surface wave launch apparatus of this invention;

[0023] FIG. 3A is an end elevation view of the surface wave launch of FIG. 2, while FIG. 3B is an enlarged end elevation view of the coaxial adapter and wire adapter portions of the surface wave launch of FIG. 3A;

45 [0024] FIG. 4A is an end elevation view of a wire adapter of this invention as installed on a single wire conductor, while FIG. 4B is a top view of a wire adapter as installed on a single wire conductor, showing the taper to the single wire conductor;

[0025] FIG. 5 is a side elevation cross-sectional view of an alternate dualband embodiment for a coaxial adapter of this invention; and

50 [0026] FIG. 6A is a perspective view of the flared horn portion of an alternate embodiment of the surface wave launch of this invention; while FIG. 6B is a cross-sectional view of the flared horn of FIG. 6A, and FIG. 6C is a detail view of an optional rolled edge for the outer mouth of the flared horn.

Best Mode for Carrying Out the Invention

55 [0027] FIG. 1 is a schematic view of a prior art surface wave launch device 10. Prior art surface wave launch 10 includes conical launch 12 and coaxial connector 14, both connected to wire conductor 16 covered by an outer dielectric sheath 18. Mounting of the prior art launch device 10 requires that wire 16 be broken, so that the launch may be threaded

on. This presents both mechanical and electrical problems to the installer of such a device, particularly if the launch is to be installed onto a pre-existing single conductor line.

[0028] Referring to FIGS. 2 through 6C, wherein like reference numerals refer to like components in the various views, there is illustrated therein a new and improved surface wave launch apparatus of this invention.

[0029] FIG. 2 is a side elevation cross-sectional view of a first embodiment of the improved apparatus 20 for launching a surface wave onto a single conductor transmission line 21 (either with or without an outer dielectric covering). Surface wave launch 20 includes a flared horn or cone portion 22, a coaxial adapter portion 24, and a wire adapter portion 26.

[0030] The entire launch device may be cast or formed from a single piece of metal if desired. However, for the purpose of this description, construction of the inventive apparatus will be divided into sections for clarity as follows: (a) the construction of the coaxial adapter; (b) the construction of the flared cone or "horn"; and (c) the construction of the wire adapter. Construction here is described for use with coaxial connections with 50 ohm characteristic impedance, but other designs are possible by modifying the dimensions. Similarly, this description shows a launch apparatus designed to operate simultaneously on two US ISM bands centered around 2.44 GHz. and 5.3 GHz. Other choices are possible by changing the dimensions of the multiband choke sections and the size of the open end of the flared cone, as is well known in the art.

[0031] In the first embodiment of the improved surface wave launch apparatus of this invention, as depicted in FIGS. 2 through 4, construction of the coaxial adapter portion 24 consists of the multiband choke sections 30, comprised of a 19 ohm section 32, a 50 ohm section 34, and another 50 ohm extension section 36, along with a shorting end 38 (opposite non-shortend 39) and a mounted coaxial connector 40. The coaxial connector 40 is mounted with its outer (ground) connection attached to the outer sleeve 42 which is provided with a hole for the connector pin 44 or inner conductor to pass through. The pin extends into the inside of the sleeve 42 and makes low impedance electrical contact with the wire adapter 26. The flared horn 22, wire adapter 26, and coaxial adapter 24 each include a longitudinal slot 23, 46, and 47, respectively, provided for mounting onto the single conductor line without breaking the line. The lower impedance choke section 32, approximately 19 ohms, is created by increasing the outer diameter of the wire adapter over a portion of the distance between the connector pin 44 and the end short 38. The inner diameter of the coaxial sleeve and the outer diameter of the wire adapter are chosen to provide the required impedances.

[0032] The wire adapter 26 shown here makes electrical contact with the single wire conductor 21 at downstream terminus 48 beyond the mouth 50, the widest dimension of the flare on the flared cone 22, effectively providing an electro-mechanical attachment to the wire at that point. The other wire adapter terminus 49 is preferably only a mechanical attachment.

[0033] FIGS. 4A and 4B illustrate the wire adapter 26 as installed on a single wire conductor 21. This connection is required to provide a low impedance between the wire adapter and the single conductor wire across both operating bands of the launch. It is desirable for the wire adapter 26 to be as thin as is mechanically practical since its dimensions decrease the impedance at the mouth of the flared cone. Additionally, there is an impedance discontinuity at the terminus 48 of the wire adapter 26 which is minimized when the step in diameter between the wire adapter and the wire is small. Tapering the end of the wire adapter, as along tapered section 52, helps minimize this discontinuity. The length of the taper is preferably at least a quarter wave at the lowest operating frequency.

[0034] Direct electrical contact between the terminus 48 of the wire adapter and the wire 21 is provided by metal contacts such as "tacks" 54 which are driven through the wire adapter 26, through any dielectric which is present, and into the wire conductor. These tacks may be further secured with a dielectric compression band of the "TyWrap" variety.

[0035] Good electrical contact is also required among the end short 38, the end 56 of the outer sleeve 42 and the wire adapter 26. Copper, brass and aluminum are all reasonable candidates for the construction of these coaxial adapter portion components. For lowest losses, copper or silver should be plated onto the current carrying surfaces or used for the entire coaxial adapter portion 24 and wire adapter portion 26.

[0036] FIG. 5 is a side elevation cross-sectional view of an alternate dualband embodiment for a coaxial adapter 60 of this invention. This embodiment utilizes a triaxial structure providing a bushing/triax outer conductor 62, a triax intermediate conductor 64, and using the single conductor/triax center line 66 as the third and central conductor of the assembly. This method allows coupling to and launching of the surface wave mode onto the central line but requires only a single electrical and mechanical contact onto that line, i.e., shorting point 68 located at the end, shorting block 70. Two separate coaxial cavities are formed, one between the intermediate line 64 and the central line 66, and a second between the outer conductor 62 and the intermediate line 64. The intermediate line 64 is tapered at the open end 72 where the coaxial cable contact is made at connection 74. Coupling 76 couples the adapter section to the narrow end 78 of the flared horn. The two coaxial cavities, along with the tapered line provide good coupling to the central line across two separate bands without requiring any physical contact which could be problematic for outdoor use due to environmental concerns.

[0037] For the construction of the flared cone section in both embodiments, the cone or "horn" section may be cast or formed from either metal or from a non-conducting material and metalized after fabrication. As for the coaxial adapter section, for lowest losses copper or silver should be plated onto the current carrying surfaces or used directly for the

entire interior of the flared cone section.

[0038] While the flared cone may be fabricated from multiple flat sheet metal subsections to approximate the desired exponential tapered shape, the preferred method of construction is to create a three-dimensional curved surface which exactly represents the desired exponential taper. This taper is such that the resulting impedance of the coaxial line formed by the flared cone outer conductor and the wire adapter inner conductor ranges from the coaxial adapter extension section impedance (50 ohms) to a higher impedance which is that of a coaxial line having an outer conductor inner dimension the same as the mouth of the flared cone, and an inner conductor of the same dimensions as the wireless adapter.

[0039] In the first embodiment of FIGS. 2 and 3, the flared cone diameter is exponentially tapered between these two end limits, as shown. The flare angle 72 of the flared cone 22 (FIG. 2), measured from the non-shortened end 39 of the coaxial adapter portion 24 to the center of the opening, is preferably between 40 and 60 degrees. The higher impedance at the mouth 50 of the flared cone 22, as described above, should be as high as possible, and preferably over 200 ohms. This prescribes a minimum diameter for the flared cone mouth 50.

[0040] In the second embodiment illustrated in FIG. 6, the diameter throughout the midsection of the flared cone 100 is substantially exponentially tapered while the change of taper at the ends (narrow end 102 and mouth 104) falls to zero. This arrangement can improve the broadband characteristics of the launch. To arrive at particular dimensions, it is useful to consider the entire cone from the perspective of a broadband coaxial line matching transformer. As with the first embodiment of FIGS. 2 and 3, the higher impedance at the mouth 104 of the flared cone 100 should be as high as possible, and preferably over 200 ohms. FIG. 6B shows the dimensions of this second embodiment. Also analogous to the flared cone of the first embodiment, the cone 100 includes a longitudinal slot 106 enabling direct mounting onto a wire.

[0041] As detailed in FIG. 6C, the edge 108 of the outer mouth 104 of the flared horn may be rolled smoothly rather than simply terminating. This can be advantageous for reducing surface wave to radiated mode conversion and improving transmission characteristics of the surface wave mode.

[0042] Construction of the wire adapter and end short is also different for the two embodiments. In the first embodiment of FIGS. 2 and 3, the wire adapter 26 serves to allow a variety of wire shapes and sizes to be used with the launch. The wire adapter 26 serves to "build up" the dimensions of whatever wire is being used in order to create a 50 ohm coaxial transmission line section no matter what type of wire is being used. It also serves as a means for making a low impedance connection to the wire and to provide mechanical mounting and robustness to the launch. Although not described here, it should be noted that it is also possible to create a low impedance UHF or microwave connection to the wire without actually contacting the wire through the use of open quarterwave choke sections which use either the wire dielectric or an additional dielectric between the wire adapter and the wire conductor.

[0043] For the case where circular wire is being adapted, the wire adapter 26 may have a circular internal shape, exclusive of the longitudinal slot 46, in which the circular single wire lays (see FIGS. 3B and 4A). For this case, the wire adapter 26 may be constructed by cutting copper tubing lengthwise with a band saw. The end short 38 may be constructed from a copper disk, slightly larger than the outer diameter of the outer sleeve 42, and providing a hole of the same diameter as the wire adapter outer diameter (see FIGS. 2 and 3B).

[0044] In the second embodiment (FIG. 5), no physical contact is required, so it is possible to accommodate multiple wire diameters by simply providing different hole diameters in the end, shorting block 68. The electrical design of the dual coaxial cavity structure is tolerant of considerable variation in line size without a great deal of sacrifice in performance. For radically different central wire diameters, it may be necessary to modify the dimensions of the coaxial cavities as well as the flared horn.

[0045] Assembly of the launch also differs with the two embodiments. For the first embodiment (FIGS. 2 through 4), a hole the diameter of the coaxial connector pin 44 is provided in the wire adapter 26. The coaxial connector 40 is first soldered to the outer sleeve 42 and then while the wire adapter 26 is held in position, the center pin may be placed in the hole and soldered. This assembly is then soldered together with the 19 ohm section 32 and the end short 38, completing the coaxial adapter section 24. The flared cone 22 may then be soldered to the non-shortened end 39 of the coaxial section.

[0046] Depending upon requirements, mechanical strength and hermeticity may be improved by filling the flared cone 22 and coaxial adapter 24 with a low loss, low dielectric constant material. However, if this is done, dimensions may have to be modified to achieve the desired impedances.

[0047] For the first embodiment of the launch, as shown in FIGS. 2 through 4, dimensions and materials may be as follows:

Flared Horn Length	3.5 inch
Flared Horn Mouth Diameter	3.5 inch
Outer Sleeve Inner Diameter	.60 inch
Wire Adapter Outer Diameter	.26 inch
Wire Adapter Length	8.0 inch

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(continued)

	Single Wire Diameter	.23 inch
	19 ohm section Diameter	.44 inch
5	19 ohm section length	.91 inch
	50 ohm section Diameter	.26 inch
	50 ohm section length	.61 inch
	50 ohm extension length	1.4 inch
10	Coaxial Connector	type SMA or N

All material except for the connector is copper.

[0048] For the second embodiment of the launch, as shown in FIGS. 5 and 6, dimensions and materials may be as follows:

15	Flared Horn Length	3.5 inch
	Flared Horn Mouth Diameter	7 inch
	Coupling	1" US Schedule L copper coupling
	Bushing	1" to 1/2" US Schedule L copper bushing
20	Triax Intermediate Conductor	1/2" US Schedule L copper pipe
	End, Shorting Block	Aluminum
	Central Wire Diameter	.25 to .32 inch
	Coaxial Connector	type SMA or N
25	Dimension A	1.78 inch
	Dimension B	1.40 inch
	Dimension C	.85 inch
	Dimension D	.75 inch

30 **[0049]** The completed surface wave launch may be mounted to an existing single wire conductor as follows. For the first embodiment, illustrated in FIGS. 2 through 4, the wire adapter attachment devices (metal contacting tacks 54) are first installed to establish good electrical contact and mechanical robustness. A dielectric compression band (e.g. "Ty-Wrap") may be used to further secure the wire adapter to the wire. Dielectric filler or covering may be inserted into the flared horn to meet environmental requirements. For the second embodiment, illustrated in FIG. 5, the end, shorting
35 block 68 is drilled to form a bore to fit the wire, and is mounted in sandwich or clamshell fashion around the wire.

[0050] After mounting the device the single wire transmission line may be used over the entire frequency and band ranges supported just as other types of transmission lines fitted with coaxial connectors would be. Transmitters, receivers, filters and frequency selective devices may be added external to the device and connected to the coaxial connector to suit the desired application. Although shown in the figures as a coaxial cable connector, this connector may also be for
40 direct connection to electronic circuitry located immediately adjacent to the coaxial section of the inventive launch, thus allowing the launch to be part of an integrated communications assembly.

[0051] Accordingly, the present invention may be characterized as a launch apparatus for launching a surface wave onto a single conductor transmission line, the launch apparatus comprising a flared cone portion; a coaxial adapter portion connected to the flared cone portion; a wire adapter portion for coupling the coaxial adapter portion to the line; and a longitudinal slot in the flared cone portion, coaxial adapter portion, and wire adapter portion to enable direct
45 placement of the launch apparatus onto the line for installation.

[0052] Alternatively, the invention may be characterized as a method for launching a surface wave onto a single conductor transmission line, the method comprising the steps of providing a launch apparatus having a flared cone portion, a coaxial adapter portion connected to the flared cone portion, and a wire adapter portion for coupling the coaxial
50 adapter portion to the line; providing a longitudinal slot in the flared cone portion, coaxial adapter portion, and wire adapter portion; and placing the launch apparatus over the line for installation.

[0053] The above disclosure is sufficient to enable one of ordinary skill in the art to practice the invention, and provides the best mode of practicing the invention presently contemplated by the inventor. While there is provided herein a full and complete disclosure of the preferred embodiments of this invention, it is not desired to limit the invention to the exact
55 construction, dimensional relationships, and operation shown and described. Various modifications, alternative constructions, changes and equivalents will readily occur to those skilled in the art and may be employed, as suitable, without departing from the scope of the invention. Such changes might involve alternative materials, components, structural

arrangements, sizes, shapes, forms, functions, operational features or the like.

[0054] Therefore, the above description and illustrations should not be construed as limiting the scope of the invention, which is defined by the appended claims.

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Claims

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1. A launch apparatus for launching a surface wave onto a single conductor transmission line, said launch apparatus comprising:

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a flared cone portion (22);
a coaxial adapter portion (24) connected to said flared cone portion;
a wire adapter portion (26) for coupling said coaxial adapter portion to the line; and **characterised by**
a longitudinal slot (23,47,46) in said flared cone portion, coaxial adapter portion, and wire adapter portion to
enable direct placement of said launch apparatus onto the line for installation.

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2. The launch apparatus of claim 1 wherein said flared cone portion comprises a continuously curving horn.

3. The launch apparatus of claim 1 wherein said flared cone portion comprises a three-dimensional curved surface.

4. The launch apparatus of claim 1 wherein said flared cone portion includes a pair of ends, and said flared cone portion is exponentially tapered between said pair of ends.

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5. The launch apparatus of claim 4 wherein the taper proximate said pair of ends falls to zero.

6. The launch apparatus of claim 1 wherein said flared cone portion has a flare angle of between 40 and 60 degrees.

7. The launch apparatus of claim 1 wherein said coaxial adapter portion includes a multiband choke section.

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8. The launch apparatus of claim 1 wherein said coaxial adapter portion includes a mounted coaxial connector bearing a pin to make low impedance electrical contact with said wire adapter portion.

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9. The launch apparatus of claim 1 wherein said coaxial adapter portion includes a triaxial structure providing an outer conductor, an intermediate conductor, and a central conductor.

10. The launch apparatus of claim 9 wherein said coaxial adapter portion central conductor comprises the transmission line.

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11. The launch apparatus of claim 1 wherein said coaxial adapter portion includes a single electrical and mechanical contact onto the transmission line.

12. The launch apparatus of claim 11 wherein said single electrical and mechanical contact comprises a shorting block.

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13. The launch apparatus of claim 12 wherein said shorting block includes a bore sized to fit the transmission line, and is mounted around the transmission line.

14. The launch apparatus of claim 1 wherein said coaxial adapter portion includes two separate coaxial cavities.

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15. The launch apparatus of claim 1 wherein said wire adapter portion includes a tapered section to minimize discontinuity with the transmission line.

16. The launch apparatus of claim 1 wherein said wire adapter portion includes metal contacts with the transmission line.

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17. The launch apparatus of claim 1 wherein said flared cone portion is constructed of metal.

18. The launch apparatus of claim 1 wherein said coaxial adapter portion is constructed of metal.

19. The launch apparatus of claim 1 wherein said wire adapter portion is constructed of metal.

20. A method for launching a surface wave onto a single conductor transmission line, said method comprising the steps of:

5 providing a launch apparatus having a flared cone portion (22), a coaxial adapter portion (24) connected to said flared cone portion, and a wire adapter portion (26) for coupling said coaxial adapter portion to the line;

characterised by providing a longitudinal slot (23, 47, 46) in said flared cone portion, coaxial adapter portion, and wire adapter portion; and

placing said launch apparatus over the line for installation.

10 21. The method for launching a surface wave onto a single conductor transmission line of claim 20 further including the step of providing an electrical and mechanical contact onto the transmission line.

15 22. The method for launching a surface wave onto a single conductor transmission line of claim 21 wherein said step of providing an electrical and mechanical contact onto the transmission line comprises providing metal contacts with the line.

20 23. The method for launching a surface wave onto a single conductor transmission line of claim 21 wherein said step of providing an electrical and mechanical contact onto the transmission line comprises providing a shorting block around the line.

25 24. The method for launching a surface wave onto a single conductor transmission line of claim 20 wherein said step of providing a launch apparatus includes the step of tapering the wire adapter to reduce impedance and minimize discontinuity with the wire.

30 25. The method for launching a surface wave onto a single conductor transmission line of claim 20 wherein said step of providing a launch apparatus includes the step of providing a coaxial adapter having a triaxial structure.

35 26. The method for launching a surface wave onto a single conductor transmission line of claim 25 wherein said step of providing a coaxial adapter having a triaxial structure includes forming two separate coaxial cavities.

40 27. The method for launching a surface wave onto a single conductor transmission line of claim 26 wherein said step of providing a coaxial adapter having a triaxial structure includes tapering the adapter where contact is made with the line.

45 28. The method for launching a surface wave onto a single conductor transmission line of claim 20 wherein said step of providing a flared cone comprises constructing a cone from metal.

50 29. The method for launching a surface wave onto a single conductor transmission line of claim 20 wherein said step of providing a flared cone comprises constructing a cone from metalized non-conducting material.

40 **Patentansprüche**

45 1. Einspeisevorrichtung zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung, wobei die Einspeisevorrichtung umfasst:

einen aufgeweiteten Trichterabschnitt (22);

einen koaxialen Adapterabschnitt (24), der mit dem aufgeweiteten Trichterabschnitt verbunden ist;

einen Kabeladapterabschnitt (26) zum Koppeln des koaxialen Adapterabschnitts mit der Leitung; und **gekennzeichnet durch**

50 einen Längsschlitz (23, 47, 46) in dem aufgeweiteten Trichterabschnitt, koaxialen Adapterabschnitt und Kabeladapterabschnitt, um die direkte Anordnung der Einspeisevorrichtung auf der Leitung zur Installation zu ermöglichen.

55 2. Die Einspeisevorrichtung von Anspruch 1, worin der aufgeweitete Trichterabschnitt ein kontinuierlich gekrümmtes Horn aufweist.

3. Die Einspeisevorrichtung von Anspruch 1, worin der aufgeweitete Trichterabschnitt eine dreidimensional gekrümmte Oberfläche aufweist.

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4. Die Einspeisevorrichtung von Anspruch 1, worin der aufgeweitete Trichterabschnitt ein Paar von Enden aufweist, und der aufgeweitete Trichterabschnitt zwischen dem Endenpaar exponentiell verjüngt ist.
5. Die Einspeisevorrichtung von Anspruch 4, worin die Verjüngung nahe dem Endenpaar auf Null abfällt.
6. Die Einspeisevorrichtung von Anspruch 1, worin der aufgeweitete Trichterabschnitt einen Aufweitungswinkel von zwischen 40 und 60° hat.
7. Die Einspeisevorrichtung von Anspruch 1, worin der koaxiale Adapterabschnitt einen Mehrband-Drosselabschnitt enthält.
8. Die Einspeisevorrichtung von Anspruch 1, worin der koaxiale Adapterabschnitt einen angebrachten koaxialen Verbinder enthält, der einen Stift trägt, um einen elektrischen Kontakt niedriger Impedanz mit dem Kabeladapterabschnitt herzustellen.
9. Die Einspeisevorrichtung von Anspruch 1, worin der koaxiale Adapterabschnitt eine triaxiale Struktur enthält, die einen äußeren Leiter, einen zwischenliegenden Leiter und einen mittleren Leiter vorsieht.
10. Die Einspeisevorrichtung von Anspruch 9, worin der mittlere Leiter des koaxialen Adapterabschnitts die Übertragungsleitung aufweist.
11. Die Einspeisevorrichtung von Anspruch 1, worin der koaxiale Adapterabschnitt einen einzigen elektrischen und mechanischen Kontakt auf der Übertragungsleitung enthält.
12. Die Einspeisevorrichtung von Anspruch 11, worin der einzelne elektrische und mechanische Kontakt einen Kurzschlussblock aufweist.
13. Die Einspeisevorrichtung von Anspruch 12, worin der Kurzschlussblock eine Bohrung enthält, die so bemessen ist, dass sie auf die Übertragungsleitung passt, und um die Übertragungsleitung herum angebracht ist.
14. Die Einspeisevorrichtung von Anspruch 1, worin der koaxiale Adapterabschnitt zwei separate koaxiale Vertiefungen enthält.
15. Die Einspeisevorrichtung von Anspruch 1, worin der Kabeladapterabschnitt einen verjüngten Abschnitt aufweist, um eine Diskontinuität mit der Übertragungsleitung zu minimieren.
16. Die Einspeisevorrichtung von Anspruch 1, worin der Kabeladapterabschnitt Metallkontakte mit der Übertragungsleitung enthält.
17. Die Einspeisevorrichtung von Anspruch 1, worin der aufgeweitete Trichterabschnitt aus Metall aufgebaut ist.
18. Die Einspeisevorrichtung von Anspruch 1, worin der koaxiale Adapterabschnitt aus Metall aufgebaut ist.
19. Die Einspeisevorrichtung von Anspruch 1, worin der Kabeladapterabschnitt aus Metall aufgebaut ist.
20. Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung, wobei das Verfahren die Schritte umfasst:

Vorsehen einer Einspeisevorrichtung mit einem aufgeweiteten Trichterabschnitt (22), einem koaxialen Adapterabschnitt (24), der mit dem aufgeweiteten Trichterabschnitt verbunden ist, und einem Kabeladapterabschnitt (26) zum Koppeln des koaxialen Adapterabschnitts auf die Leitung; **gekennzeichnet durch** Vorsehen eines Längsschlitzes (23, 47, 46) in dem aufgeweiteten Trichterabschnitt, koaxialen Adapterabschnitt und Kabeladapterabschnitt; und Anordnen der Einspeisevorrichtung auf der Leitung zur Installation.
21. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 20, das ferner den Schritt enthält, einen elektrischen und mechanischen Kontakt auf der Übertragungsleitung vorzusehen.

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22. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 21, worin der Schritt des Vorsehens eines elektrischen und mechanischen Kontakts auf der Übertragungsleitung das Vorsehen von Metallkontakten mit der Leitung aufweist.
- 5 23. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 21, worin der Schritt des Vorsehens eines elektrischen und mechanischen Kontakts auf der Übertragungsleitung das Vorsehen eines Kurzschlussblocks um die Leitung herum aufweist.
- 10 24. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 20, worin der Schritt des Vorsehens einer Einspeisevorrichtung den Schritt enthält, den Kabeladapter zu verjüngen, um die Impedanz zu reduzieren und eine Diskontinuität mit dem Draht zu minimieren.
- 15 25. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 20, worin der Schritt des Vorsehens einer Einspeisevorrichtung den Schritt enthält, einen koaxialen Adapter mit einer triaxialen Struktur vorzusehen.
- 20 26. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 25, worin der Schritt des Vorsehens eines koaxialen Adapters mit einer triaxialen Struktur enthält, zwei separate koaxiale Vertiefungen auszubilden.
- 25 27. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 26, worin der Schritt des Vorsehens eines koaxialen Adapters mit einer triaxialen Struktur enthält, den Adapter dort zu verjüngen, wo der Kontakt mit der Leitung hergestellt wird.
- 30 28. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 20, worin der Schritt des Vorsehens eines aufgeweiteten Trichters umfasst, einen Trichter aus Metall aufzubauen.
- 30 29. Das Verfahren zum Einspeisen einer Oberflächenwelle auf eine Einzelleiter-Übertragungsleitung von Anspruch 20, worin der Schritt des Vorsehens eines aufgeweiteten Trichters umfasst, einen Trichter aus metallisiertem nichtleitendem Material aufzubauen.

Revendications

- 35 1. Dispositif d'excitation destiné à exciter une onde de surface sur une ligne de transmission monoconducteur, ledit appareil d'excitation comprenant :
- 40 une partie (22) de cône évasé ;
une partie (24) d'adaptateur coaxial reliée à ladite partie de cône évasé ;
une partie (26) d'adaptateur de fil destinée à coupler ladite partie d'adaptateur coaxial à la ligne ; et
caractérisé par
une fente longitudinale (23, 47, 46) dans ladite partie de cône évasé, ladite partie d'adaptateur coaxial, et ladite partie d'adaptateur de fil pour permettre le placement direct dudit appareil d'excitation sur la ligne pour l'installation.
- 45 2. Appareil d'excitation de la revendication 1 dans lequel ladite partie de cône évasé comprend une corne incurvée de manière continue.
- 50 3. Appareil d'excitation de la revendication 1 dans lequel ladite partie de cône évasé comprend une surface incurvée tridimensionnelle.
4. Appareil d'excitation de la revendication 1 dans lequel ladite partie de cône évasé comporte une paire d'extrémités, et ladite partie de cône évasé est effilée de manière exponentielle entre ladite paire d'extrémités.
- 55 5. Appareil d'excitation de la revendication 4 dans lequel la conicité à proximité de ladite paire d'extrémités diminue jusqu'à zéro.
6. Appareil d'excitation de la revendication 1 dans lequel ladite partie de cône évasé a un angle d'évasement compris

entre 40 et 60 degrés.

- 5
7. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur coaxial comporte un tronçon d'étranglement à plusieurs bandes.
8. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur coaxial comporte un connecteur coaxial monté supportant une tige pour établir un contact électrique à faible impédance avec ladite partie d'adaptateur de fil.
- 10
9. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur coaxial comporte une structure triaxiale fournissant un conducteur extérieur, un conducteur intermédiaire, et un conducteur central.
10. Appareil d'excitation de la revendication 9 dans lequel ledit conducteur central de la partie d'adaptateur coaxial comprend la ligne de transmission.
- 15
11. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur coaxial comporte un seul contact électrique et mécanique sur la ligne de transmission.
12. Appareil d'excitation de la revendication 11 dans lequel ledit seul contact électrique et mécanique comprend un bloc de court-circuit.
- 20
13. Appareil d'excitation de la revendication 12 dans lequel ledit bloc de court-circuit comporte un alésage dont la taille s'adapte à la ligne de transmission, et est monté autour de la ligne de transmission.
- 25
14. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur coaxial comporte deux cavités coaxiales séparées.
15. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur de fil comporte un tronçon effilé pour minimiser la discontinuité avec la ligne de transmission.
- 30
16. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur de fil comporte des contacts métalliques avec la ligne de transmission.
17. Appareil d'excitation de la revendication 1 dans lequel ladite partie de cône évasé est réalisée en métal.
- 35
18. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur coaxial est réalisée en métal.
19. Appareil d'excitation de la revendication 1 dans lequel ladite partie d'adaptateur de fil est réalisée en métal.
- 40
20. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur, ledit procédé comprenant les étapes qui consistent :
- à prévoir un appareil d'excitation ayant une partie (22) de cône évasé, une partie (24) d'adaptateur coaxial reliée à ladite partie de cône évasé, et une partie (26) d'adaptateur de fil destinée à coupler ladite partie d'adaptateur coaxial à la ligne ;
- 45
- caractérisé par** le fait
- de prévoir une fente longitudinale (23, 47, 46) dans ladite partie de cône évasé, ladite partie d'adaptateur coaxial, et ladite partie d'adaptateur de fil ; et
- de placer ledit appareil d'excitation sur la ligne pour installation.
- 50
21. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 20 comportant en outre l'étape consistant à fournir un contact électrique et mécanique sur la ligne de transmission.
22. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 21 dans lequel ladite étape consistant à fournir un contact électrique et mécanique sur la ligne de transmission comprend la fourniture de contacts métalliques avec la ligne.
- 55
23. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 21

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dans lequel ladite étape consistant à fournir un contact électrique et mécanique sur la ligne de transmission comprend la fourniture d'un bloc de court-circuit autour de la ligne.

- 5
24. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 20 dans lequel ladite étape de fourniture d'un appareil d'excitation comporte l'étape consistant à effiler l'adaptateur de fil pour réduire l'impédance et minimiser la discontinuité avec le fil.
- 10
25. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 20 dans lequel ladite étape de fourniture d'un appareil d'excitation comporte l'étape consistant à fournir un adaptateur coaxial ayant une structure triaxiale.
- 15
26. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 25 dans lequel ladite étape de fourniture d'un adaptateur coaxial ayant une structure triaxiale comporte le fait de former deux cavités coaxiales séparées.
- 20
27. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 26 dans lequel ladite étape de fourniture d'un adaptateur coaxial ayant une structure triaxiale comporte le fait d'effiler l'adaptateur où un contact est établi avec la ligne.
- 25
28. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 20 dans lequel ladite étape de fourniture d'un cône évasé comprend la réalisation d'un cône en métal.
- 30
29. Procédé d'excitation d'une onde de surface sur une ligne de transmission monoconducteur de la revendication 20 dans lequel ladite étape de fourniture d'un cône évasé comprend la réalisation d'un cône en matériau non conducteur métallisé.
- 35
- 40
- 45
- 50
- 55

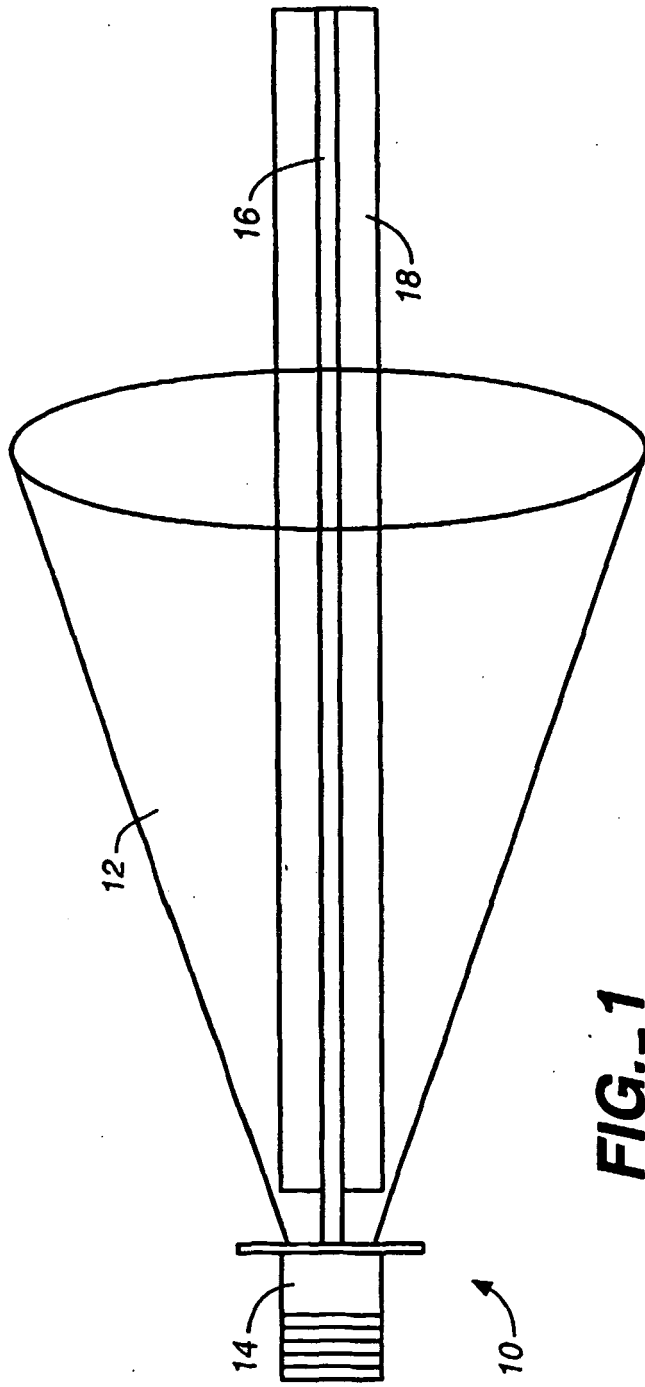


FIG. 1

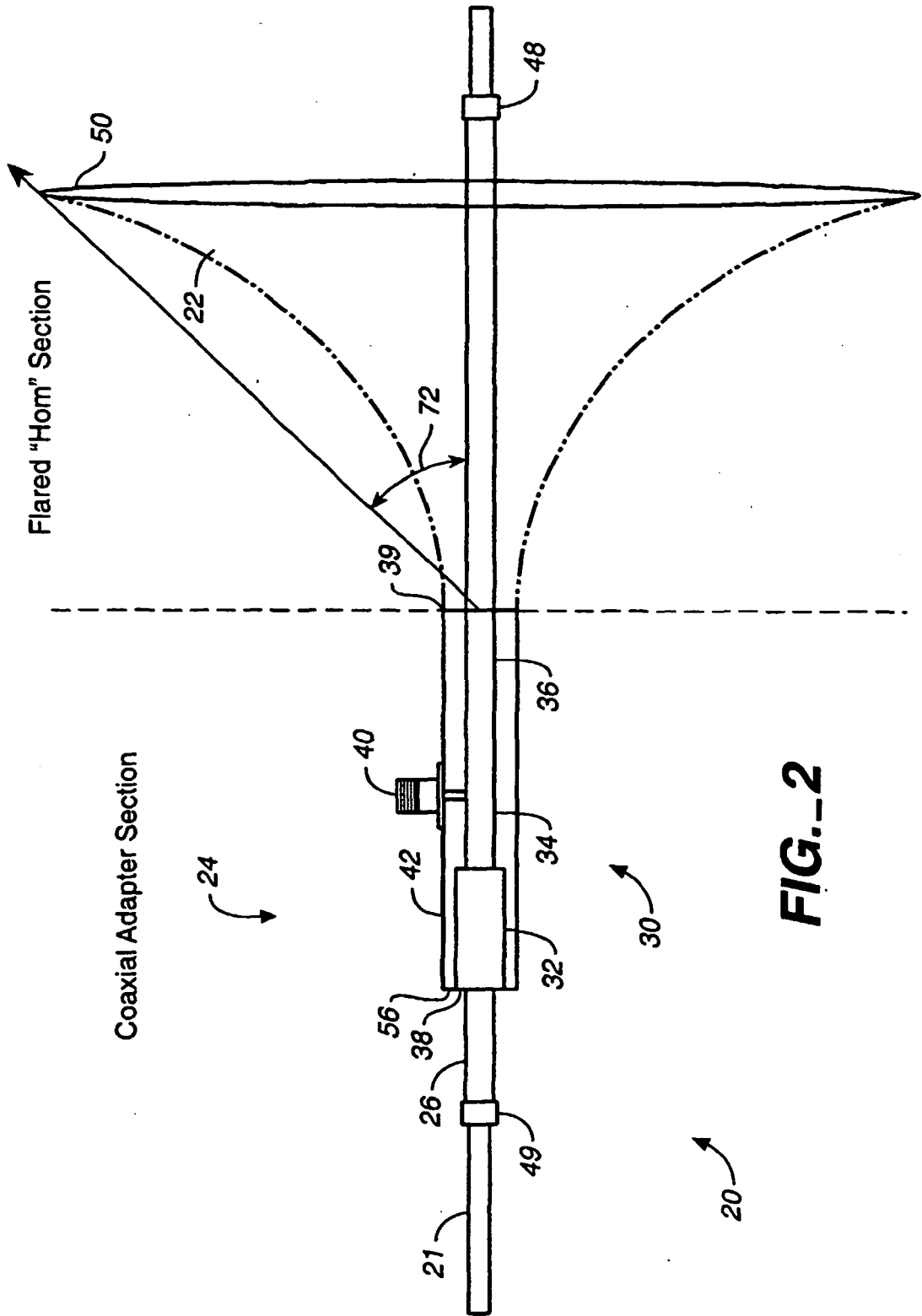


FIG. 2

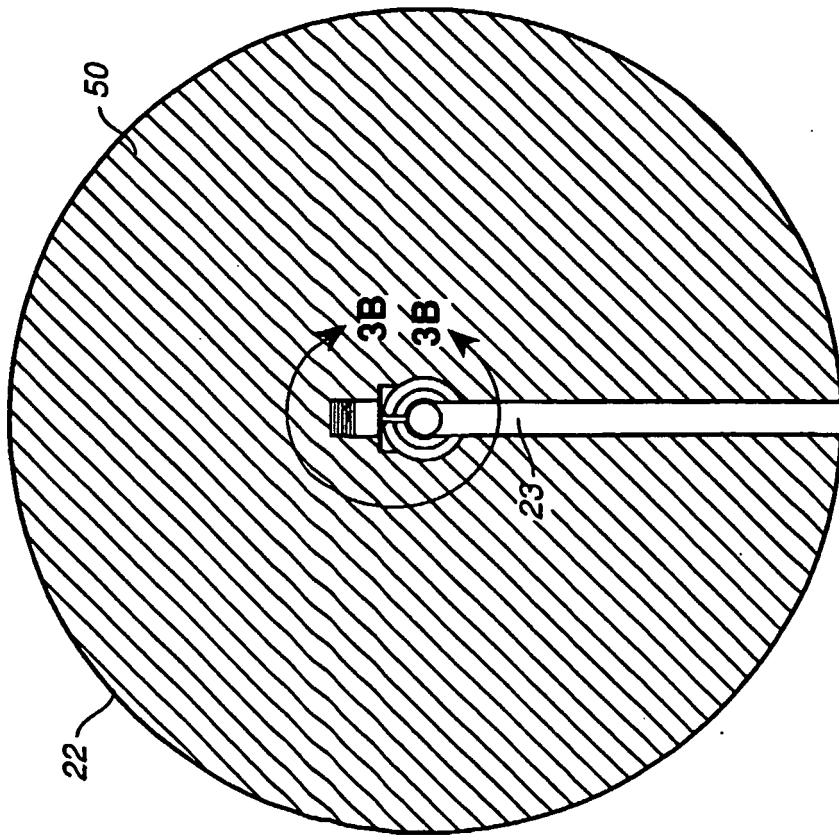


FIG.-3A

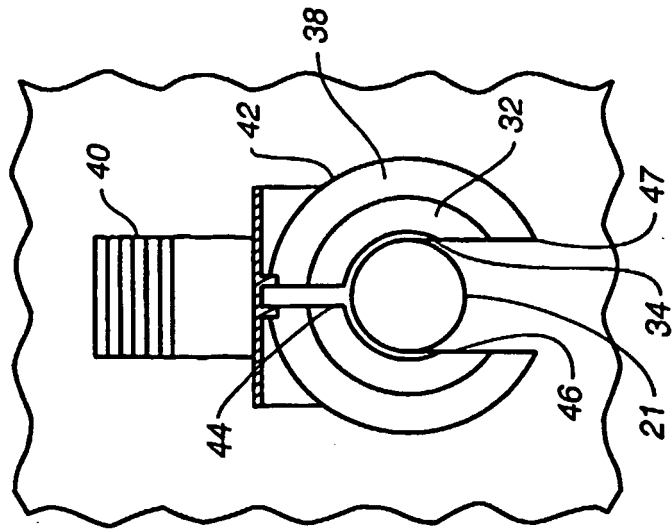


FIG.-3B

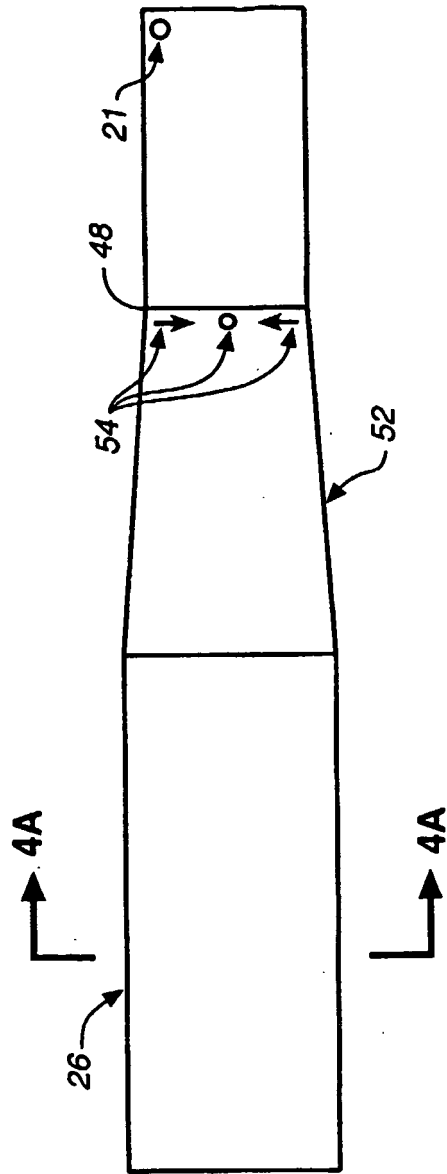


FIG. 4B

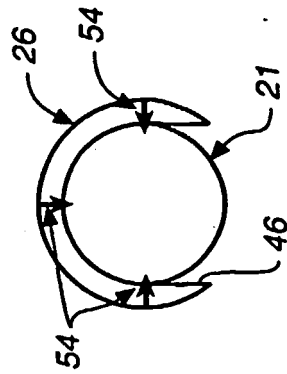


FIG. 4A

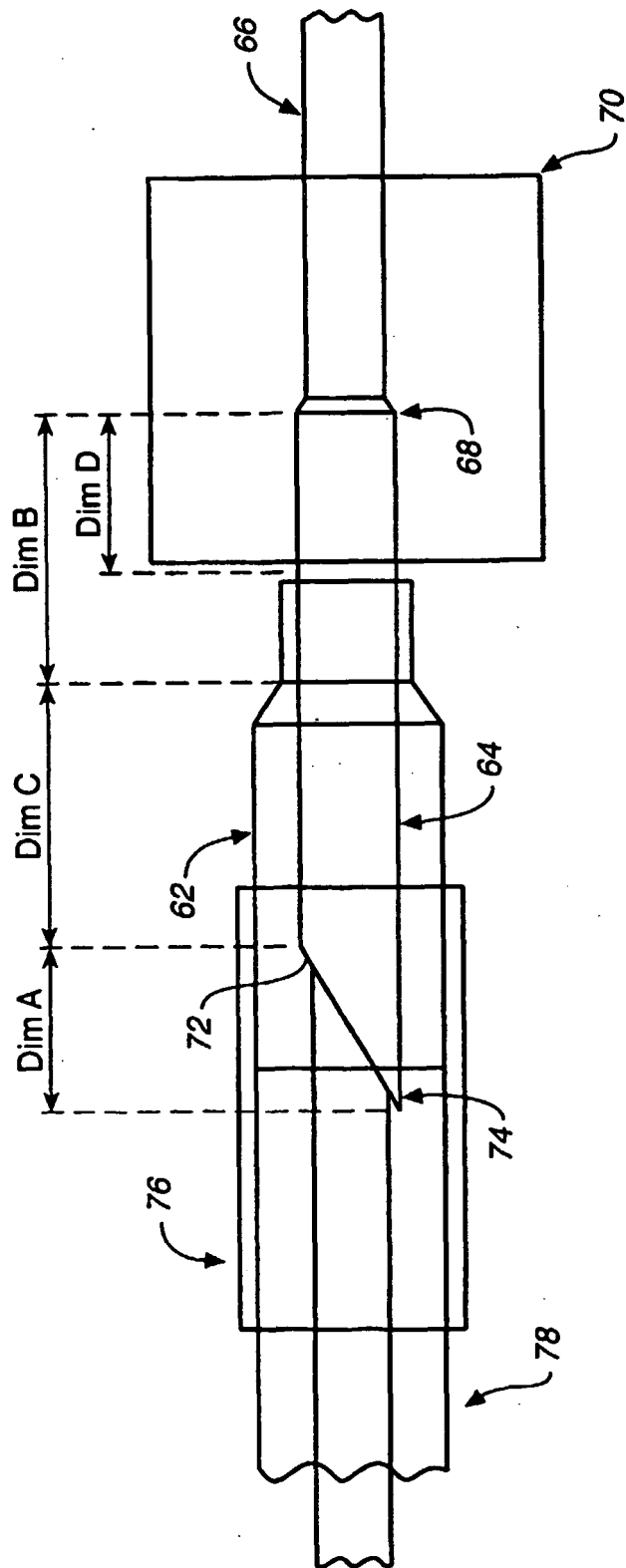


FIG. 5

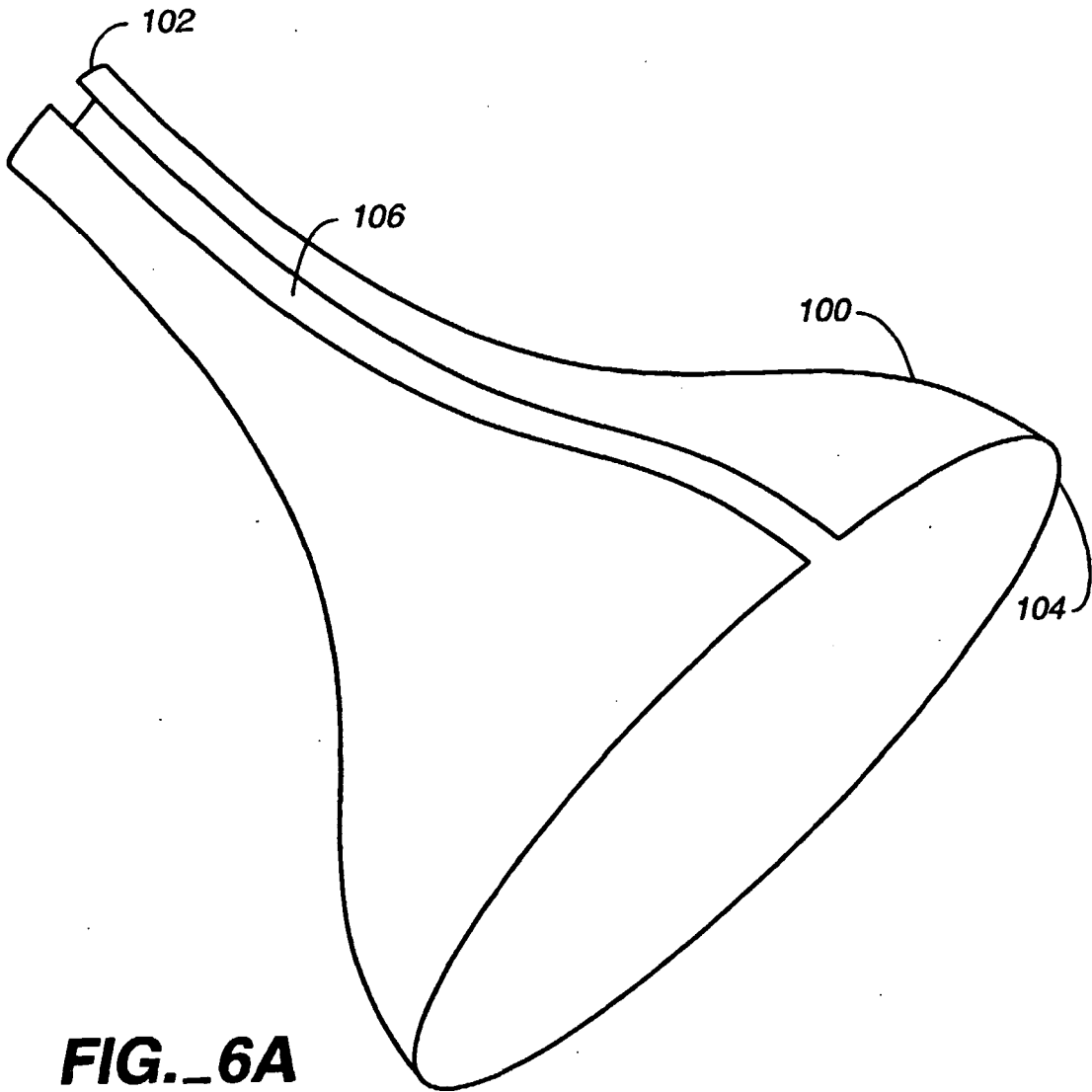


FIG._6A

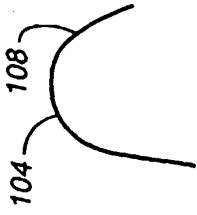
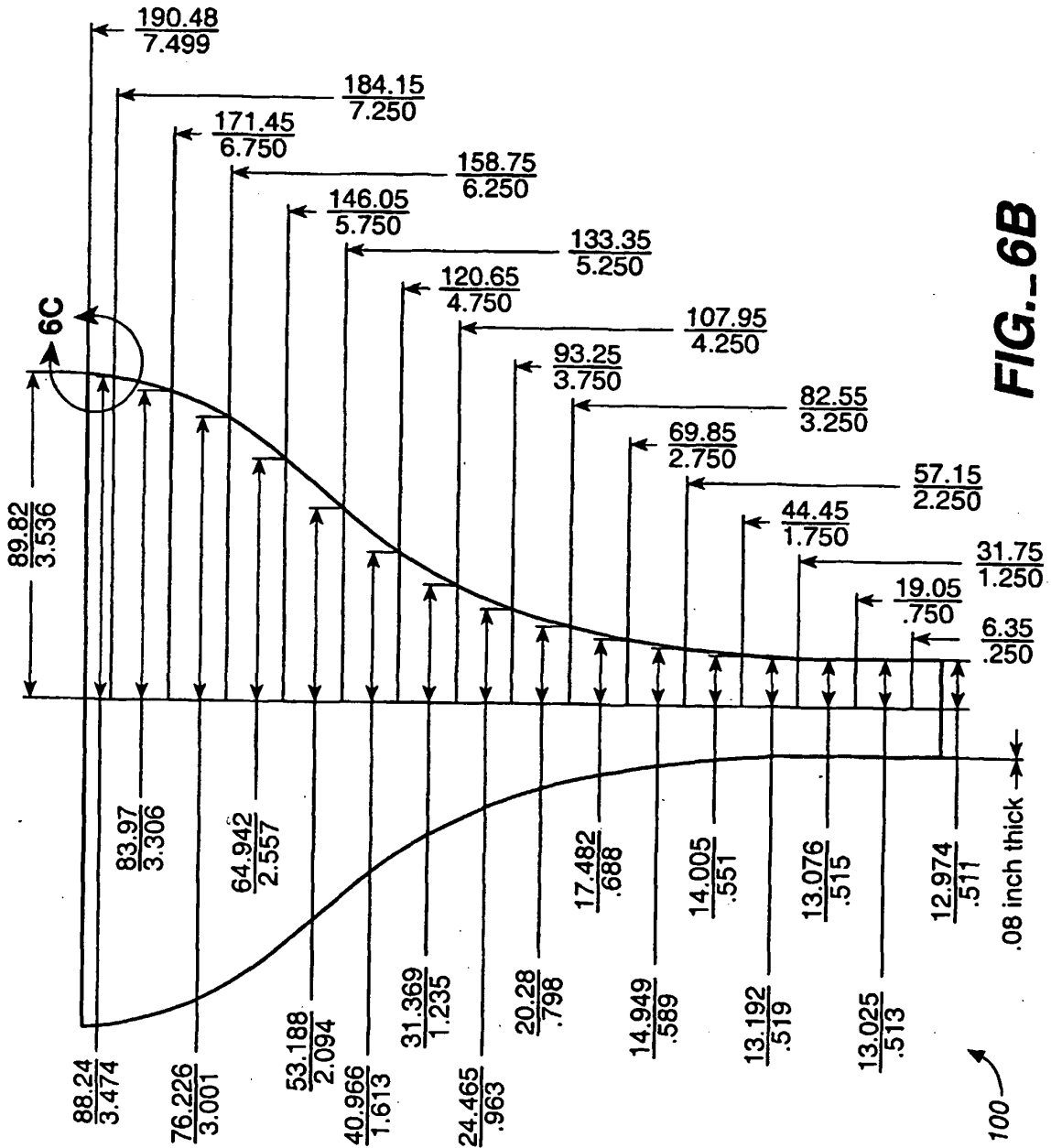


FIG.-6C



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