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(54) RADIATION-EMITTING CABLE AND A RADIATION-EMITTING ELEMENT COMPRISED THEREIN

(57) The inventive radiation-emitting cable comprises a coaxial cable segment (1) and at least two radiation-emitting elements (5). Said radiation-emitting element is embodied in the form of an insert. The external conductor (4), dielectric layer (3) and the internal conductor of the coaxial cable segment (1) are provided with an opening which is embodied therein and used for tapping electromagnetic energy by means of said insert. The insert is made from an insulated wire segment whose one end is placed in the opening and the other end is arranged outside of the external conductor (4) of the coaxial cable segment (1) in such a way the electromagnetic energy is irradiated into environment. The electromagnetic energy tapping and irradiating device is embodied in the form of said radiation-emitting element (5).

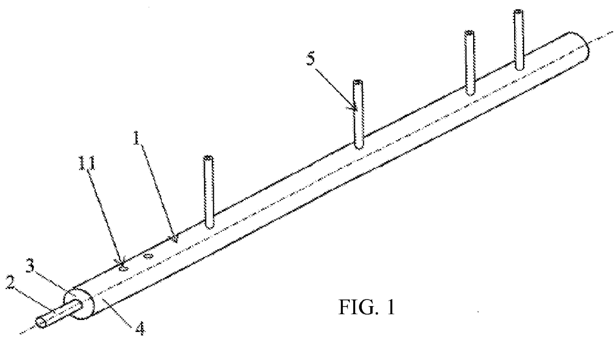

FIG. 1

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Description

Field of the Invention

[0001] This invention relates to radio equipment and may be used as a radiating element in antenna systems or as a distributed antenna-feeder system for wireless access to telecommunications of various types.

Prior Art

[0002] Various designs of radiating coaxial cables are known in the art, which combine the properties of radio-transmitting line and a long antenna. The function of tapping and radiating in such devices is performed by openings (slots) or groups of openings made in an external conductor of a coaxial line section (WO, A, 9917401), (RU, A, 2231180).

[0003] Radiating cables are used in various tunnels on highways and railroads, in subways, underground structures, such as multistoried car parking lots, basements of large buildings and even in yards behind large multistoried buildings made of reinforced concrete, and they are intended for removing "dead zones" or radio shadow areas.

[0004] The cheapest and simplest radiating cables have uniformly distributed radiating openings. For example, such openings are provided in Radio Frequency Systems cables of RCF 78-50, RLF 78-50, RLKW -78-50 series or cables RI 17-33, RI 50-24-31, RI 50-33-31, etc. produced in Russia.

[0005] A disadvantage of a radiating cable of such type is electromagnetic energy radiation non-uniformity. Due to losses in a cable, the radiated power level on the powering side of the cable is many times higher than in the cable end. Thus, for a radiating cable having the length of 500 meters, diameter 7/8", and with losses 4.1 dB/100 meters at 900 MHz the difference in the radiation level in the beginning and in the end of the cable is more than 20 dB, i.e., 100 times. The use of such a cable leads to excess consumption of electromagnetic energy in the beginning of the cable and a loss in this energy in the end of the cable, and, consequently, to a decrease in the communication area.

[0006] Radiating cables are known that have a non-uniform distribution of radiating openings along a cable (US, A, 5276413).

[0007] Such cables are manufactured by a number of companies, including Radio Frequency Systems, under the generic name "vario". See, for example, RLV 114-50. WDCS Product Catalogue, Edition 1, 06.02.050, KB 17/00197-01, p. 42.

[0008] The technical solution in the said patent (US, A, 5276413) uses a regular change in opening location density from the beginning to the end of a radiating cable. The opening location density is regularly doubled when the system losses increase along the cable up to a set limiting value above which the communication quality is unacceptable. System losses in a radiating cable are defined as the sum of cable propagation losses plus losses from propagation of the radiation electromagnetic energy from the cable to a receiver dipole antenna located at a 2-meter distance from the radiating cable.

[0009] It is known from the said technical solution stated in the US patent that the dependence of system losses for a cable with the length of 560 meters, having attenuation losses in a cable without openings, is -3.7 dB/100 meters. Radiation losses for the first 138 meters of a radiating cable with openings made at the 1-meter distance of a radiating cable are 0.35 dB/100 meters, and the total losses in a cable are -4.05 dB/100 meters. The value of 90 dB is taken as the limiting value of system losses. When this value is reached at a distance of 138 meters, the number of openings is doubled. The radiation losses increase to 0.7 dB/100 meters, and the total losses in a cable reach 4.4 dB/100 meters.

[0010] A next doubling of opening number and, consequently, doubling of radiation losses will result in shortening the respective segments to 127, 110, 86, 60, and 38 meters, and the opening number per one meter will be increased to 2, 4, 8, 16, and 32, respectively.

[0011] Thus, doubling of openings from 1 to 32 per 1 meter enables to keep the necessary radiation level for maintaining communication at 900 MHz in a radiating cable having the length of 560 meters.

[0012] If a radiating cable having a different length is required, then another distribution of openings along the cable length will be optimal.

[0013] Such radiating cables are commercially available in fixed lengths, as a rule of 600, 700, 800 meters, etc., and differ not only in length, but also by the distribution structure of radiating elements - openings.

[0014] A disadvantage of the technical solution described in the said patent (US, A, 52776413) is the complexity of manufacturing and a wide variety of radiating cable types ("vario") that are intended for meeting various requirements to cable length, propagation loss, cable radiation, etc., which all lead to their low-scale and, consequently, very expensive production. Furthermore, the difference of a practically needed cable length at its laying from the produced length range of radiating cables creates unreasonably great cable waste during installation. Changes in radiating openings distribution density along length of radiating cables ("vario") are intended only for ensuring constant radiation levels. At the same time, different radiation levels are required in real conditions, e.g., when laying a cable of one type through tunnels, platforms, large and small premises, etc.

[0015] Thus, the limitations of the above-described technical solutions are:

- when a radiating cable has a great length, its radiating elements - openings, which are most distant from the point of connecting an electromagnetic energy source, radiate the lowest level of electromagnetic energy, and, due to the constant taping factor of each radiating opening, the more distant is a radiating opening (group of openings) from an electromagnetic energy source, the lesser will be such level;

- the constant nature of the taping factor does not enable adjusting radiated energy in dependence from specific operation conditions of a radiating cable (absence or presence of dead zones), and making radiating openings at a certain spacing before laying a cable, as it is usually done in commercially available radiating cable types, leads to useless loss of electromagnetic energy at sections having no dead zones of radio reception.

[0016] The closest is a radiating cable comprising a section of coaxial cable made of an inner conductor surrounded by a dielectric layer and an external conductor, and at least two radiating elements made with the possibility of taping and radiating electromagnetic energy into the surrounding space, wherein a opening, which is intended for taping electromagnetic energy by means of an insert, is made in the external conductor, the dielectric layer and the inner conductor of a coaxial cable segment (RU, A, 2181518).

[0017] The insert in this device is made in the form of a screw, which is installed into the inner conductor of the coaxial cable by means of a threaded connection, and the screw head is in the dielectric layer of the coaxial cable. Radiating elements in this device, as in the above known devices, are openings made in the external conductor of the coaxial cable.

[0018] Comparing to other devices, this technical solution has the following advantages. The insert serves for increasing tapping factor and decreasing the standing wave ratio due to inserting into the cable inner conductor a radial insert which cross-section area is less than the surface area of the radiating opening. Such an insert enables to compensate for irregularity of the external conductor by introducing opposite sign irregularity. Moreover, such an insert enables to raise the radiation level and improve its uniformity owing to changing the path of high-frequency current in the inner conductor and making it closer to the plane of radiating openings. An insert may be provided with a conducting attachment enabling to adjust to minimum VSWR values.

[0019] The disadvantages of this technical solution are:

- at a great length of a radiating cable and uniform distribution of openings those openings, which are most distant from the point of connecting an electromagnetic energy source, radiate electromagnetic energy at an insufficient level;
- making radiating openings at a certain spacing before laying a cable results in useless loss of electromagnetic energy at sections having no dead zones of radio reception;
- lack of adaptability, since sizes of radiating openings are always selected proceeding from a particular frequency set by the developer, and it is not possible to decrease such sizes after making them in the external conductor;
- a low radiating capacity of one opening results in the necessity of installing a great number of matching inserts that are complex for manufacturing and adjusting;
- the unfeasibility of obtaining minimum and maximum possible tapping factors at simultaneous tuning and adjusting a device for operating in a wide frequency band;
- the complex structure and time-consuming tuning due to the necessity of using a threaded connection for a screw or a conducting attachment, since the screw and the conducting attachment should be screwed/unscrewed for the purpose of adjusting the insert position, as these elements are located inside the external conductor of a coaxial cable;
- complexity of installing such a device at already laid section of a main coaxial cable, e.g., in a metro tunnel or in other rather long premises.

[0020] A device for tapping and radiating electromagnetic energy - a radiating element - is known from the technical solution described in a Russian patent, which is included in a coaxial cable and comprises a section of a coaxial cable consisting in an inner conductor surrounded by a dielectric layer and an external conductor, wherein an opening intended for tapping and radiating electromagnetic energy by means of an insert is made in the external conductor, the dielectric layer and the inner conductor of the coaxial cable (RU, A, 2181518).

[0021] The limitations of this technical solution are, respectively:

- lack of adaptability, since sizes of radiating openings are always selected proceeding from a particular frequency set by the developer, and it is not possible to decrease such sizes after making them in the external conductor;
- a low absolute value and a small range of adjusting the tapping factor, since an insert is always connected to the inner conductor;
- the unfeasibility of obtaining minimum and maximum possible tapping factors at simultaneous tuning and adjusting a device for operating in a wide frequency band;
- the complex structure and time-consuming tuning due to the necessity of using a threaded connection for a screw or a conducting attachment, since the screw and the conducting attachment should be screwed/unscrewed for the purpose of adjusting the insert position, as these elements are located inside the external conductor of a coaxial cable;
- complexity of installing such a device at already laid section of a coaxial cable, e.g., in a metro tunnel or in other rather long premises.

Summary of the Invention

[0022] The present invention is based on the objective of creating a radiating cable that helps remove irrational loss of electromagnetic energy having place at excess electromagnetic energy radiation, which enables using lesser power sources or increasing useful length of radiating cable for a source with a given power, this also ensures operation in a wide frequency band, increases the range for adjusting of tapping factor, simplifies the design and ensures simple adjustment and installation, i.e., ensures the possibility of installing a radiating element in any necessary place at earlier laid sections of a main coaxial cable. Another objective is to create a corresponding radiating element ensuring the possibility of operation in a wide frequency band, an increase in the range of the tapping factor adjustment, simplification of its structure, adjustment and installation, in order to improve the performance characteristics of a radiating cable and a device for tapping and radiating electromagnetic energy. Still another objective is to create a radiating cable implementing the possibility of forming a communication zone of an arbitrary form with the condition of operatively modernizing and incrementing it in the process of operation.

[0023] For the purpose of achieving the said objectives and obtaining the stated technical effect on the basis of a known radiating cable which comprises a coaxial cable section made of an inner conductor surrounded by a dielectric layer, an external conductor, and at least two radiating elements made with the possibility of tapping and radiating electromagnetic energy into the surrounding space, an opening, which is intended for tapping electromagnetic energy by means of an insert, is made in the external conductor, the dielectric layer and the inner conductor of the coaxial cable. According to the invention the said insert is made of a section of an isolated wire, one end of which is installed in the opening and the other end is located outside the external conductor of the coaxial cable section for the purpose of radiating electromagnetic energy into the surrounding space.

[0024] Additional embodiments of the inventive radiating cable are possible, where it is advisable that:

- the said insert is installed tightly with the possibility of moving it in the opening for the purpose of changing the electromagnetic energy tapping factor;
- the said isolated wire of the insert is made rigid with the possibility of positioning it transversely to the coaxial cable section;
- a dielectric case is introduced, wherein an opening is made, and the end of the isolated wire, which is located outside the external conductor, is installed within the dielectric case, the said dielectric case being installed on the external conductor of the coaxial cable section and transversely to it;
- additional radiating elements are introduced, which are made in the form of openings in the external conductor of the coaxial cable section.

[0025] The stated advantages as well as specific features of this invention are explained in the description of its best embodiments with references to the appended drawings.

Brief Description of the Drawings

[0026]

Fig. 1 is a general view of the inventive radiating cable;

Fig. 2 is a longitudinal and cross section of a cable having one radiating element (a device for tapping and radiating electromagnetic energy);

Fig. 3 - same as Fig. 2, showing a dielectric case;

Fig. 4 shows VSWR dependence on a radiating element frequency;

Fig. 5 shows a layout of a radiating cable with radiating elements in a tunnel with linear sections and a turn;

Fig. 6 shows dependence of a signal level in a metro vehicle filled with passengers, when the said vehicle moves from one end of the metro tunnel to the other, and signals are emitted by four standard antennas;

Fig. 7 - same as Fig. 6, after installation of two radiating elements on a cable laid between the antennas for the purpose of liquidating a "gap" in the communication zone;

Fig. 8 - same as Fig. 6, after installation of 20 radiating elements along the whole tunnel for the purpose of forming a continuous communication zone in the whole span;

Fig. 9 shows a plot of VSWR dependence on distance for the inventive radiating cable.

Best Mode of Carrying out the Invention

[0027] The radiating cable (Fig. 1) comprises the coaxial cable section 1 comprising the inner conductor 2, which is surrounded by the dielectric layer 3, and the external conductor 4. The device has at least two or three radiating elements 5 made with the possibility of tapping and radiating electromagnetic energy into the surrounding space.

[0028] The external conductor 4, the dielectric layer 3 and the inner conductor 2 of the coaxial cable section 1 (Figs. 2, 3) are provided with the opening 6 intended for tapping electromagnetic energy by means of the insert 7. The insert 7 is made of a section of an isolated wire comprising the conductor 8 and the dielectric 9.

[0029] One end of the isolated wire is installed in the opening 6, and the other end is located outside the external conductor 4 of the coaxial cable section 1 with the possibility of radiating electromagnetic energy into the surrounding space.

[0030] The insert 7 is tightly installed with the possibility of moving it in the opening 6 (Figs. 2, 3) for the purpose of changing the electromagnetic energy tapping factor.

[0031] The isolated wire of the insert 7 may be made rigid with the possibility of positioning it transversely to the coaxial cable section 1 (Figs. 1, 2).

[0032] The isolated wire of the insert 7 may be made sufficiently soft. In such embodiment the dielectric case 10 is introduced, wherein an opening is made (Fig. 3). The end of the isolated wire, which is located outside the external conductor 4, is installed within the dielectric case 10. The dielectric case 10 is installed on the external conductor 4 (or on a shielding, which is not shown in Figs. 1 - 3 and may be made in a usual manner) of the coaxial cable section 1 transversely to it. The dielectric case 10 performs the function of fixing the insert 7 and protecting it against external actions.

[0033] The radiating cable may also comprise additional radiating elements 11 made as openings in the coaxial cable section 1 (Fig. 1).

[0034] The inventive device for tapping and radiating electromagnetic energy respectively comprises (Figs. 1, 2, 3): the coaxial cable section 1 comprising the inner conductor 2, which is surrounded by the dielectric layer 3, and the external conductor 4. The external conductor 4, the dielectric layer 3 and the inner conductor 2 of the coaxial cable section 1 are provided with the opening 6 intended for tapping electromagnetic energy by means of the insert 7. The insert 7 is made of a section of an isolated wire comprising the conductor 8 and the dielectric 9.

[0035] One end of the isolated wire is installed in the opening 6, and the other end is located outside the external conductor 4 of the coaxial cable section 1 with the possibility of radiating electromagnetic energy into the surrounding space.

[0036] The insert 7 is tightly installed with the possibility of moving it in the opening 6 (Figs. 2, 3) for the purpose of changing the electromagnetic energy tapping factor.

[0037] The isolated wire of the insert 7 may be made rigid with the possibility of positioning it transversely to the coaxial cable section 1.

[0038] The isolated wire of the insert 7 may be made sufficiently soft. In such embodiment the dielectric case 10 is introduced, wherein an opening is made (Fig. 3). The end of the isolated wire, which is located outside the external conductor 4, is installed within the dielectric case 10. The dielectric case 10 is installed on the external conductor 4 (or on an insulating lining, which is not shown in Figs. 1 and 2 and may be made in a usual manner) of the coaxial cable section 1 transversely to it. As stated above, the dielectric case 10 performs the function of fixing the insert 7 and protecting it against external actions. The radiating cable (Figs. 1-3) is operated as follows. A number of the radiating elements 5 (Fig. 1) is determined by the length of the coaxial cable section 1 and presence of radio shadow areas on the route of the radiating cable. The more shadow areas, the closer the radiating elements 5 are installed on the route, every radiating element being made of an isolated wire section comprising the conductor 8 and the dielectric 9, i.e., such devices for tapping and radiating electromagnetic energy (Figs. 2, 3) may be installed in places where they are particularly necessary.

[0039] Unlike the closest analogous solution, the opening 6 in the external conductor 4 is not radiating, but serves for passing the insert 7 made of an isolated wire inside and outside of the coaxial cable section 1.

[0040] An electromagnetic wave, when propagating in the coaxial cable section 1, excites in the insert 7 - isolated wire performing the function of a quarter-wave dipole, radio-frequency currents, which, in their turn, result in radiating electromagnetic waves into the surrounding space.

[0041] The coaxial cable section 1 is matched to the insert 7 for a given frequency band by selecting a length and a diameter of the isolated wire as well as by selecting electrical and geometric parameters of the dielectric case 10.

[0042] The electromagnetic energy tapping factor is adjusted in a wide range by moving the insert 7 and is determined by a depth of introducing the isolated wire into the coaxial cable section 1. As can be seen in Figs. 2 and 3, in the result of introducing the insert 7 the tapping factor may be changed from the maximum value (Fig. 2) to some minimum value (Fig. 3). As tests have shown, the electromagnetic energy tapping factor can be adjusted in a wide range. In the result of introducing the insert 7 the tapping factor may be changed from the maximum value (minus 10 dB) to some minimum value (minus 30 dB or less).

[0043] The ultimate simplicity of the design and convenience in installation condition the practical significance of the inventive device. The radiating element 5 may be easily installed at any segment of a long coaxial cable section 1. For this purpose the opening 6 can be drilled on the outer surface of the coaxial cable section 1. The diameter of the opening 6 is selected so as the insert 7 made of an isolated wire can be installed with certain tightness. This ensures the possibility of moving the isolated wire in the opening 6 for adjusting and changing the electromagnetic energy tapping factor. The time necessary for making an opening 6 and installing a radiating element 5 does not exceed 5 minutes.

[0044] If the isolated wire of the insert 7 is made rather rigid, then its transverse positioning relative to the coaxial cable section 1 becomes possible (Fig. 1, 2), and no supporting devices are required.

[0045] If the isolated wire of the insert 7 is made soft, e.g., of an isolated copper wire, then the dielectric case 10 is used (Fig. 3), wherein an inner hole for the isolated wire is made for the purpose of fixing the insert 7 after its moving in the opening 6. The end of the isolated wire, which is located outside the external conductor 4, is arranged within the dielectric case 10 (Figs. 2, 3). The dielectric case 10 is installed on the external conductor 4 of the coaxial cable section transversely to the latter, e.g., is attached to the shielding (not shown in Figs. 1-3) of the coaxial cable section 1 (на фиг. 1-3 не показана) with the use of a glue or a standard sealing set for radio-frequency connections.

[0046] The radiating cable may also comprise additional radiating elements 11 made in the form of openings only in the external conductor of the coaxial cable section 1 (Fig. 1). Such openings may be arranged on spots located closely to an electromagnetic energy source, where the minimum energy should be tapped from the source and radiated. Additional elements 11 in the form of openings mat be also made in a certain place by drilling corresponding openings (or groups of openings) in the external conductor 4 of the coaxial cable section 1.

[0047] The inventive device is easily tuned to a required frequency by cutting the isolated wire. The required energy is adjusted by simply changing the introduction depth of the insert 7 into the coaxial cable section 1. The cable radiating capacity may be decreased by excluding some or decreasing the number of openings 6 and the corresponding number of the radiating elements 5. The radiation level of both the radiating elements 5 located closely to an electromagnetic energy source and those located at maximum distances from the source is adjusted by changing the location of the insert 7 in the opening 6, which is more deeper, including its position within the inner conductor 2 (Fig. 2), or less deeper, e.g., in the dielectric layer 3 (Fig. 3). Electromagnetic energy losses are eliminated in the absence of reception dead zones due to the absence of radiating elements 5 installed in zones of consistent reception. The VSWR dependence on frequency for a radiating element 5 is shown in Fig. 4. A decrease in the number of radiating elements 5, as compared to the number of those made in the form of openings, enables to use sources with less electromagnetic energy power or to increase the useful length of the radiating cable for a source with a given power.

[0048] It can be seen in Fig. 5 that the radiating elements 5 on linear sections are installed with a lesser density than in a turn in the tunnel. Moreover, in the tunnel turn the radiating elements 5 are introduced to a greater depth into the coaxial cable section 1, which enables to compensate not only for attenuation in it, but also for additional losses caused by radio wave propagation in the tunnel having a sharp turn. The given example shows the possibility of adaptive formation of the radiation level in accordance with the conditions of laying the radiating cable.

[0049] The applicability and the efficiency of the inventive radiating cable have been experimentally confirmed when constructing the GSM-900 cellular network in the Moscow metro.

[0050] For the purpose of improving the communication quality in the tunnels the inventive device was used with the following parameters:

[0051] The length of the insert 7 was 95 mm, the diameter of the conductor 8 was 2 mm, the diameter of the dielectric 9 was 7 mm. The diameter of the dielectric case 10, which was made of polyethylene, was 10 mm. The diameter of the external conductor 4 of the coaxial cable 1 was 30 mm, the diameter of the inner conductor 2 was 13 mm. For forming the radiating cable inserts 7 were used, which have a tapping factor from minus 13 to minus 30 dB.

[0052] At the first stage of constructing the network in the tunnel having the length of 700 meters between two stations A and B two standard antennas (A1 and A4) were installed in the beginning and in the end of the tunnel, and two standard antennas (A2 and A3) were moved to the inner part of the tunnel to a distance of 150 meters from each side (Fig. 6). The antennas A1-A3 were connected to the coaxial cable section 1 with the use of coaxial couplers. The antennas A1 and A2 were connected to the GSM base station equipment at the metro station A, the antennas A3 and A4 were connected to the GSM base station equipment at the metro station B. The antennas installed in the tunnel had a great gain and are oriented to the tunnel inner part.

[0053] Fig. 6 shows the dependence of the signal level in a metro vehicle filled with passengers when it is moving from one end of the tunnel to the other, i.e., from the station A to the station B. Signals from different stations are shown in Fig. 6 by black curves of different intensities. The required communication quality is ensured at the signal level equal to minus 90 dBi. Four peaks of the signal are clearly seen, which correspond to the four standard antennas. It can be seen that the communication zone has gaps not only in the middle of the tunnel, but also between the antennas. The communication zone is an area where the signal level exceeds minus 90 dBm.

[0054] At the second stage radiating elements 5 were installed on the coaxial cable section 1 powering the antenna A3 moved to the tunnel. The radiating elements were made as inserts 7 in accordance with the claimed technical solution (in Fig. 7 the inserts 7 of the radiating elements 5 are marked as A5 and A6). The spacing between the radiating elements 5 was app. 40 meters, the tapping factor was minus 13 dB. A record of the signal level after installation of two inserts 7 of the radiating elements 5 is shown in Fig. 7. The two additional peaks correspond to radiation of the two additionally installed radiating elements 5 (A5 and A6). It can be seen that a gap in the communication zone remains only in the center of the tunnel.

[0055] At the third stage the tunnel standard antennas A2 and A3 were disconnected, and the coaxial cable section 1 with the radiating elements 5 (the inserts 7 made in accordance with the claimed technical solution) was laid along the whole tunnel. The spacing between the radiating elements 5 was 40 meters in the beginning and in the end and 20 meters in the center of the tunnel. The energy tapping factor was different also: from minus 30 dB in both ends of the tunnel to minus 13 dB in its center.

A record of the signal level at the third stage is shown in Fig. 8. It can be seen that when powering the coaxial cable section from both ends the average signal level is app. 75 dBi, which ensures high quality communication in the whole tunnel with a great reserve.

[0056] Fig. 9 shows a plot of VSWR dependence on distance for the coaxial cable section 1 with 18 radiating elements 6 in a tunnel having the length of 500 meters. It can be seen that for all the inserts 7 of the radiating elements 5 the VSWR value is lower than 1.15.

[0057] Thus, the claimed technical solution ensures in comparison to the closest analogous solution:

- a greater tapping value for one radiating element 5 and, consequently, their reduced number;
- a possibility of operatively managing radiated power owing to changing the introduction depth of the insert 7 into the coaxial cable section 1 for the purpose of forming a required communication zone;
- a possibility of correcting and incrementing a communication zone in the process of operating the cable;
- an ultimate simplicity of the design and installation convenience in any conditions, and, consequently, a lower cost of the inventive radiating cable.

Industrial Applicability

[0058] The inventive radiating cable and the inventive radiating device for electromagnetic energy tapping and radiating may be most successfully applied on an industrial scale in cases where it is necessary to ensure communication in cellular networks and wireless access in tunnels of various purposes, ship holds, underground structures, large business-centers, multistoried parking lots and other large and complex structures.

Claims

1. A radiating cable comprising a coaxial cable section comprising an inner conductor surrounded by a dielectric layer, an external conductor, and at least two radiating elements made with the possibility of tapping and radiating electromagnetic energy into the surrounding space, an opening, which is intended for tapping electromagnetic energy by means of an insert, being made in the external conductor, the dielectric layer and the inner conductor of the coaxial cable, **characterized in that** the said insert is made of a section of an isolated wire, one end of which is installed in the opening and the other end is located outside the external conductor of the coaxial cable section with the possibility of radiating electromagnetic energy into the surrounding space.

2. A radiating cable according to Claim 1, **characterized in that** said insert is installed tightly with the possibility of moving it in said opening for the purpose of changing the electromagnetic energy tapping factor.

3. A radiating cable according to Claim 1, **characterized in that** said isolated wire of the said insert is made rigid with the possibility of positioning it transversely to said coaxial cable section.

4. A radiating cable according to Claim 1, **characterized in that** a dielectric case is introduced wherein am opening is made, and the end of said isolated wire positioned outside said external conductor is arranged within said dielectric case, said dielectric case being arranged on said external conductor of said coaxial cable section transversely to it.

5. A radiating cable according to Claim 1, **characterized in that** additional radiating elements are introduced, which are made as holes in said external conductor of said coaxial cable section.

6. A device for electromagnetic energy tapping and radiating, which comprises a coaxial cable section made of an inner conductor surrounded by a dielectric layer and an external conductor, an opening being made in said external conductor, said dielectric layer and said inner conductor, which is intended for electromagnetic energy tapping by means of an insert, **characterized in that** said insert is made of a isolated wire section one end of which is installed in said opening and the other end is positioned outside said external conductor of said coaxial cable section with the possibility of radiating electromagnetic energy into the surrounding space.

7. A device according to Claim 6, **characterized in that** said insert is installed tightly with the possibility of moving it in said opening for the purpose of changing the electromagnetic energy tapping factor.

8. A device according to Claim 6, **characterized in that** said isolated wire of said insert is made rigid with the possibility of arranging it transversely to said coaxial cable section.

9. A device according to Claim 6, **characterized in that** a dielectric case is introduced wherein an opening is made, and the end of said isolated wire, which is positioned outside said external conductor, is arranged inside said dielectric case, said dielectric case being arranged on said external conductor of said coaxial cable section and transversely to it.

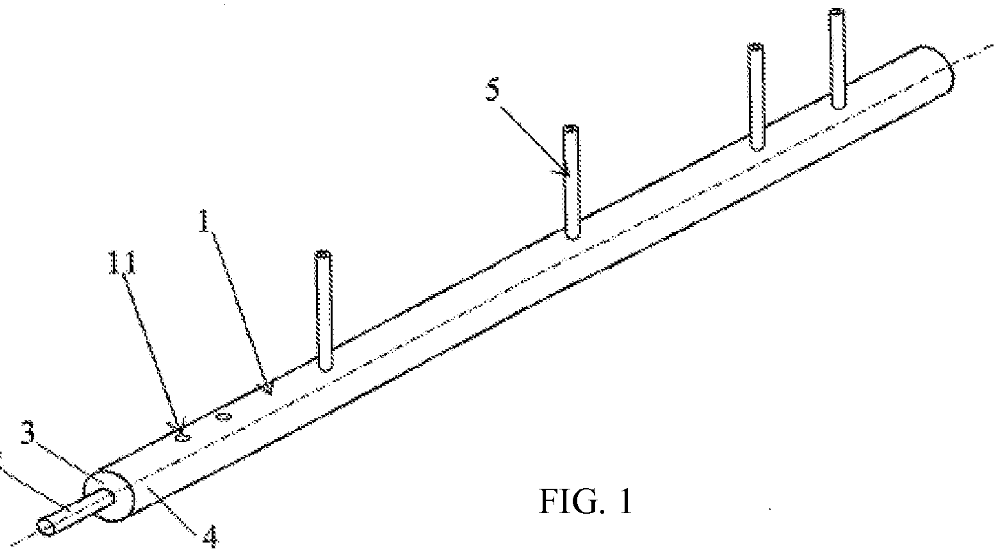


FIG. 1

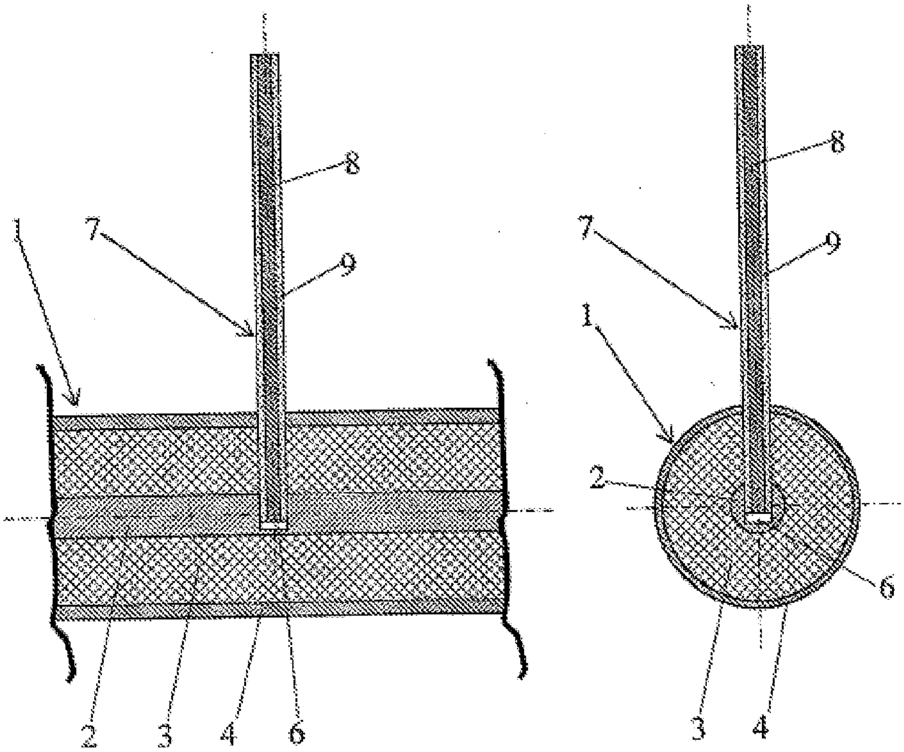


FIG. 2

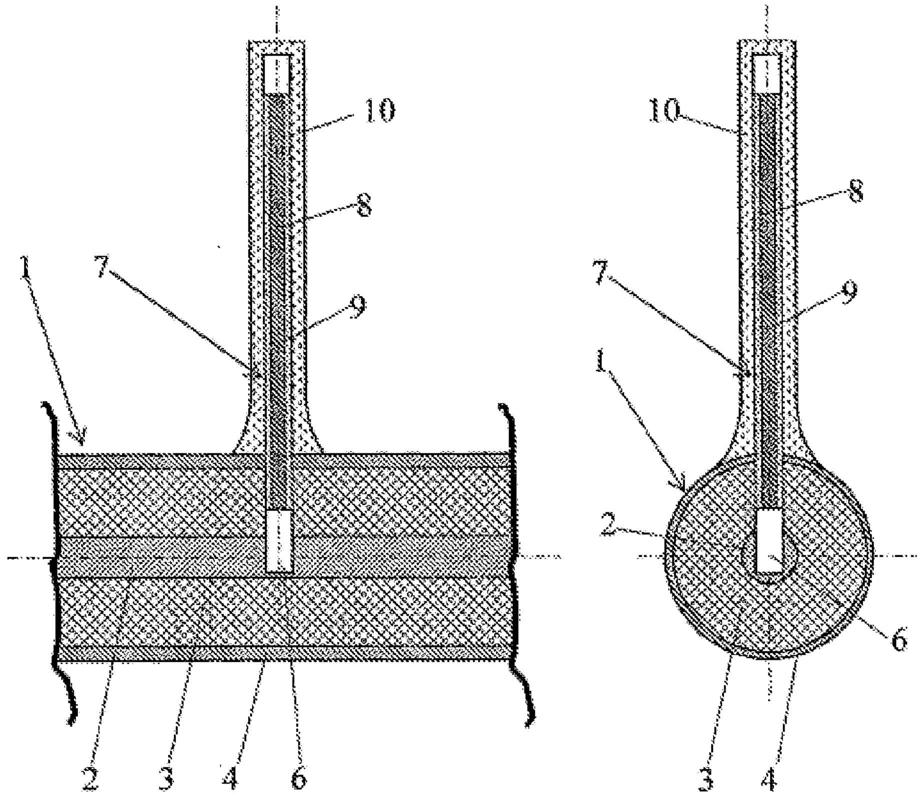

10
8
7
9
1
2
3
4
6
10
8
7
9
1
2
6
3
4

FIG. 3

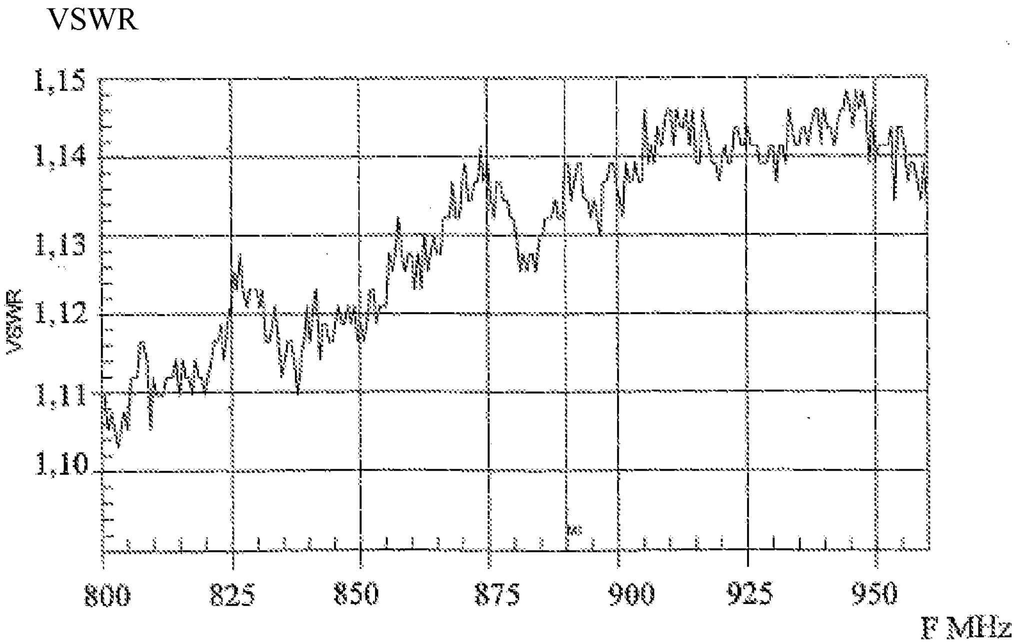

VSWR
1,15
1,14
1,13
1,12
1,11
1,10
VSWR
800
825
850
875
900
925
950
F MHz

FIG. 4

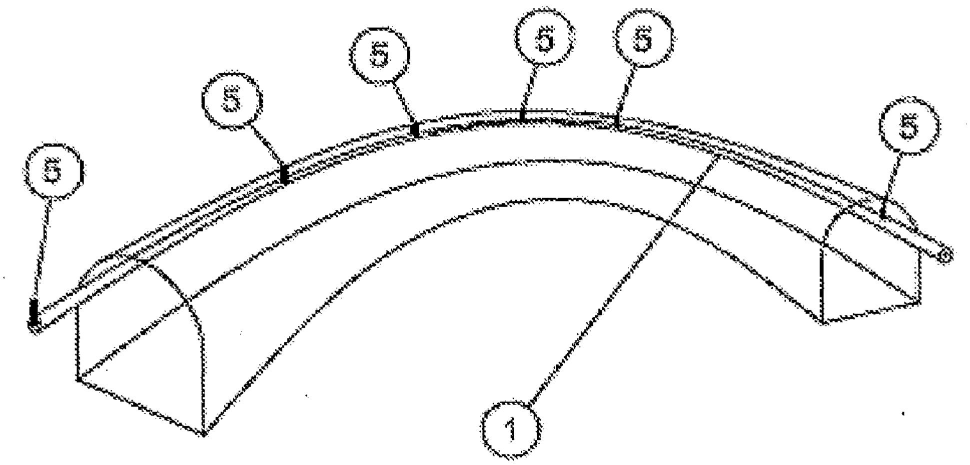

5
5
5
5
5
5
5
1

FIG. 5

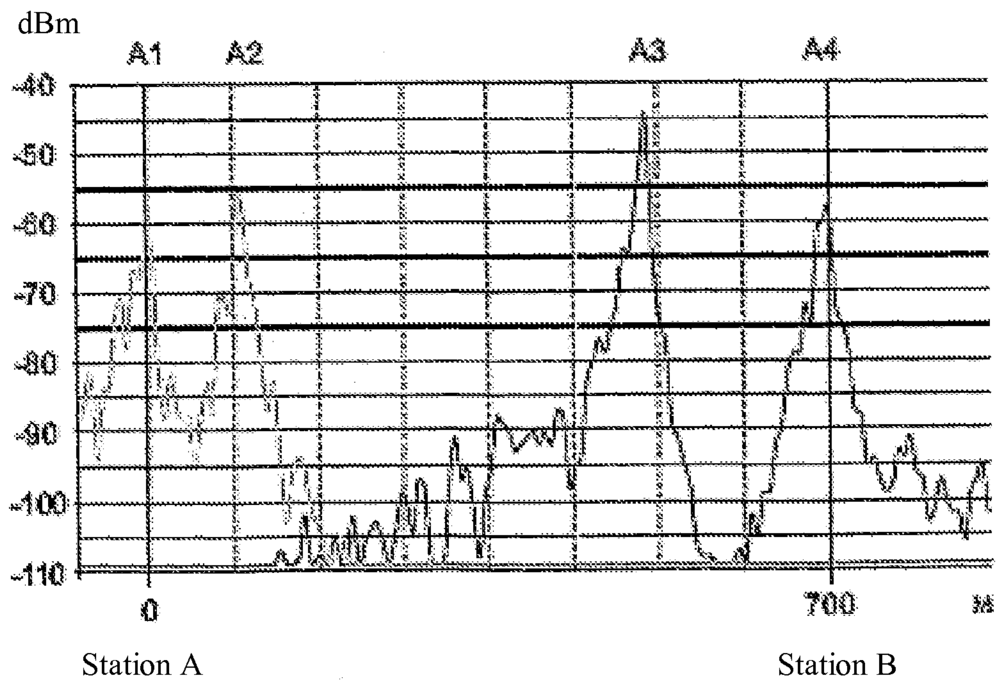
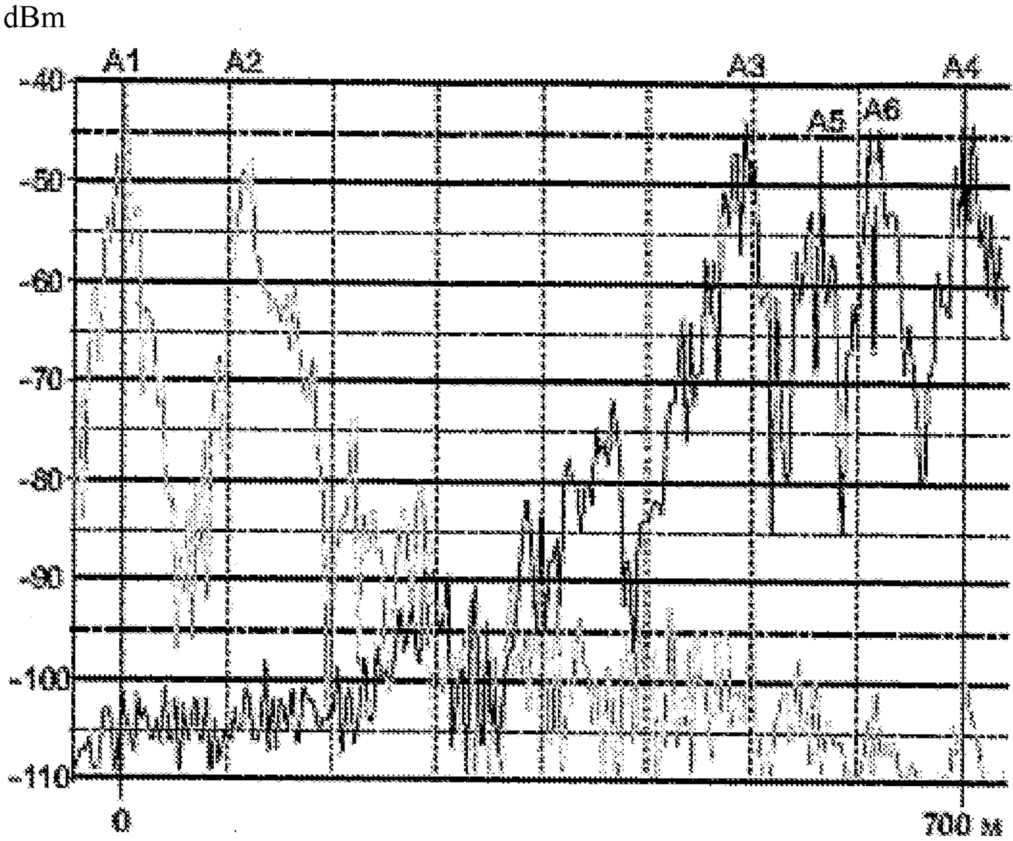
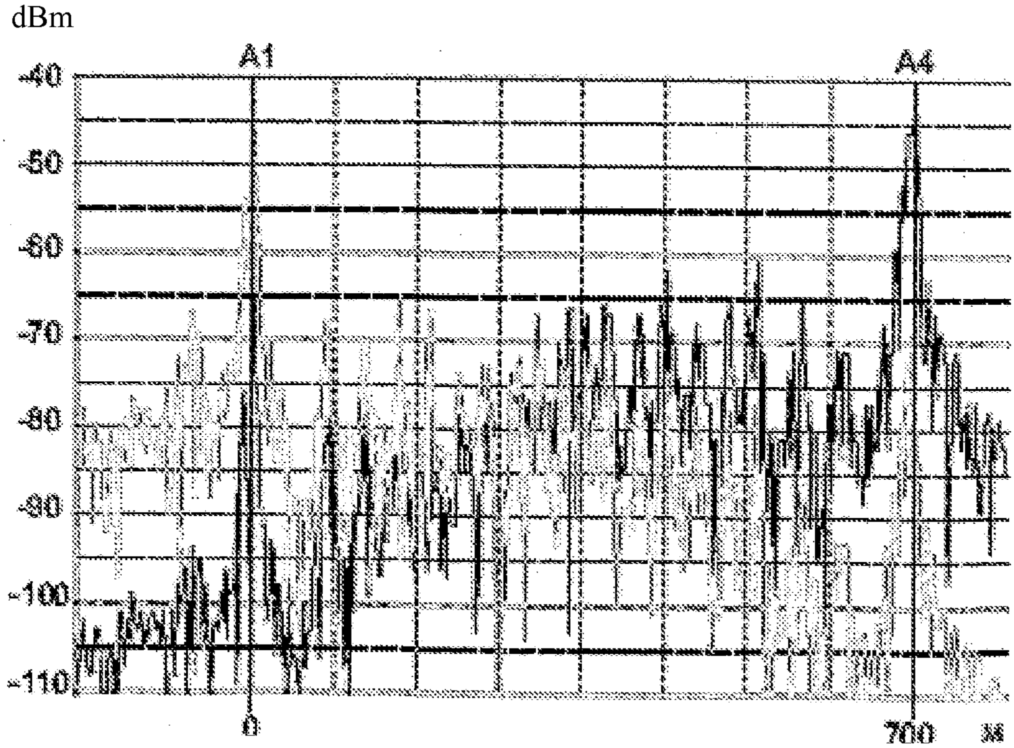

dBm
A1
A2
A3
A4
-40
-50
-60
-70
-80
-90
-100
-110
0
700
Station A
Station B

FIG. 6



Station A FIG. 7 Station B



Station A FIG. 8 Station B

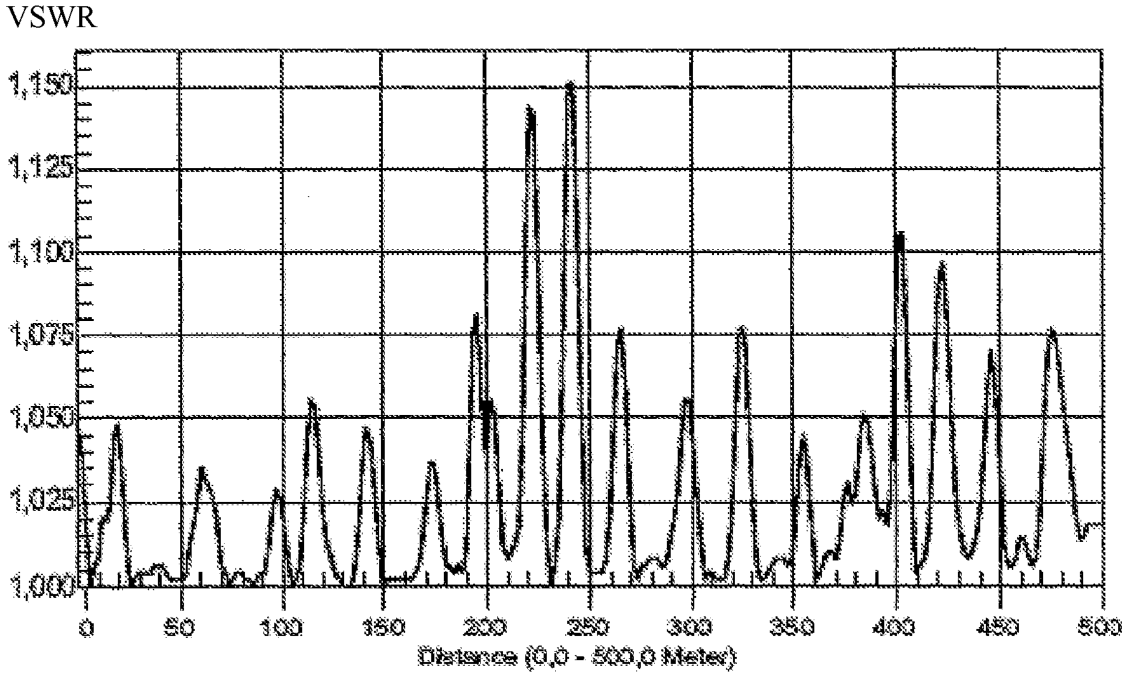

VSWR
1,150
1,125
1,100
1,075
1,050
1,025
1,000
0
50
100
150
200
250
300
350
400
450
500
Distance (0,0 - 500,0 Meter)

FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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- RU 2231180 A **[0002]**
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- US 52776413 A **[0014]**
- RU 2181518 A **[0016] [0020]**