



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/DK91/00246 (22) International Filing Date: 23 August 1991 (23.08.91) (30) Priority data: 2020/90 23 August 1990 (23.08.90) DK (71)(72) Applicant and Inventor: PEDERSEN, Willy, Palle [DK/ES]; C/AI Andalus, 12, Borbollon I, Portal 3,70,B, E-Torremolinos (ES). (74) Agent: SKØTT-JENSEN, K.; Lemmingvej 225, DK-8361 Hasselager (DK). (81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU⁺, TD (OAPI patent), TG (OAPI patent), US.		Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments. In English translation (filed in Danish).</i>
(54) Title: A MARKER OF THE ELECTROMAGNETIC RESONANCE TYPE AND A METHOD OF PRODUCING SUCH MARKERS (57) Abstract A marker of the electromagnetic resonance type is designed with a one-layer coil (6) on a ferrite core (4) having a length equal to half the length of a standard core, whereby two markers can be made out of one such standard length. The resulting short cores have a very good strength, whereby a surrounding protective housing (2) may be thin-walled, such that the entire marker may be produced with relatively small dimensions. The one-layer coil (6) conditions a high efficiency. The coil is produced as a self-carrying unit (6), which can be displaced along the core (4), and in the production the marker may be adjusted to the resonance frequency in a simple manner by displacing the coil unit until a maximum output signal is detected, whereafter the coil unit is fixed to the core in that particular position.		

+ DESIGNATIONS OF "SU"

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A MARKER OF THE ELECTROMAGNETIC RESONANCE TYPE AND A METHOD OF PRODUCING SUCH MARKERS

The present invention relates to a marker of the electromagnetical resonance type and of the kind comprising a cylindrical housing of a dielectric material housing a ferrite core, which, over a part of its length, is provided with an electrical coil in connection with a condenser, such that these latter parts will form an electric resonance circuit having a predetermined resonance frequency. The housing is cast out with a sealing moulding mass so as to be completely sealed towards the surroundings. Mostly, markers of this type are used as subterranean markers, as in a buried position they can be localized by means of special search detectors operating on the same frequency as the said resonance frequency. Thereby it is possible to mark and refind objects in the ground, e.g. pipe joints or splicing muffs on cables, or the markers can define base points in a coordinate system, in which the location of subterranean objects or conduits can be measured in, for subsequent easy refinding.

A marker of this type is known from WO 83/01306, and such markers have been used in practice through several years. For natural reasons it has been endeavoured to design the markers with a size as small as possible in view of the requirements from both a production and a utility point of view. Hereby it has been a practical and economical starting point that the markers have been based on standard manufactured ferrite cores for rod antennae, these having proved particularly well suited also for the present particular purpose, and thus it has been possible to make use of cheap standard products in the form of rods with a diameter of 9 mm and a length of 20 cm. From a utility point of view this has

been quite suitable, because the marker should produce, actuated by the detector, a resonance signal powerful enough to make it detectable in spite of the marker being placed well underneath the ground surface.

In the discussed known markers the ferrite rod is mounted in a cylindrical housing having a noticeable wall thickness, this having the purpose of frequency stabilizing the markers, when these are mounted in surroundings with different dielectrical properties. Earlier, in fact, the surrounding dielectricum had a clear influence on the resonance frequency, but later on new types of ferrite have been developed which are much less sensitive.

On this background it would have been possible to use a narrower cylinder housing, which would for more reasons be highly attractive, particularly for the work connected with the formation of the mounting holes, but the thick housing has another important property, viz. that of stabilizing the ferrite rod purely mechanically, so it has not been chosen to reduce the said wall thickness. However, also miniature markers have been developed, sized approximately as a lipstick, with specially produced ferrite cores having a diameter of some 5 mm and a length of 4-5 cm in a thin-walled housing. These markers have but a modest operational range, and they are very difficult to produce with an accurately tuned resonance frequency, which should here be explained in more detail:

It is quite usual that the preferred resonance frequency is of the magnitude 100 kHz, and with the use of a relatively thin ferrite core it is then necessary to use resonance coils having quite many windings. The coil wire is machine wound directly on the core, and even if there is used a very thin wire it is necessary to utilize almost the entire core length to hold the coil and to wind the coil with several layers of wind-

ings. The ferrite cores, even from the same series production, are not exactly uniform with respect to their magnetic properties, and if they are wound with a prescribed number of windings the result will be that the markers will exhibit a considerable spreading in their resonance frequencies. It is a possibility to work out an adjustment to the correct frequency by individually adjusting the number of the windings in the coils, but in a large production of the small and cheap markers this will imply a considerable complication.

Moreover, plural layer coils do not contribute to a high quality of the markers, because there will be a gap of non-magnetic material between the outer winding layers and the core. This will more than outbalance the advantage of the inner winding layer being wound directly on the core.

In connection with the invention it has been found that the discussed relatively large ferrite rod maintains a high efficiency even when shorted to approximately half its length, and also that with the reduced length of the rod there is still iron enough to enable the use of a single layer coil with a reasonably low number of windings, in practice some 80 windings. Furthermore it has been found that the core, thus shorted, becomes relatively much stronger, such that it will not need the said thick-walled housing for mechanical protection.

In practice all this means that it is possible to provide a mini marker, which is only slightly larger than the said 'lipstick marker', but is much more effective.

The relatively thick ferrite core, of course, would be slightly more effective if shorted only to a little more than half its original standard length, but when the starting material is a cheap standard product it is advantageous to select just half the length, because

each core member can then be made into two markers.

It could also be possible to make use of a core length somewhat smaller than half the said standard length, as the core would still be at least reasonably effective, but here the following observation should be made:

With the invention it is desired to produce markers of a good quality, also with respect to the efficiency and the frequency accuracy. As already mentioned this is bound to require an adjustment, and if such an adjustment is made with respect to the number of windings the work will be facilitated because of the relatively small number of windings in the coil. In connection with the invention, however, it has been recognized that it is possible to make use of quite another method of adjustment, namely an axial displacement of the coil on the core, and that is easy to do, when the coil is made as a separate unit. Now, when the coil is wanted to be a one-layer coil, preferably with a reasonably large wire thickness, then the coil will have a certain required length, in practice e.g. 4-6 cm, and for enabling the said displacement adjustment it will then be necessary that the core has a certain overlength, whereby the discussed 'half length', i.e. some 10 cm, has been found to be quite suitable. With the use of noticeably shorter cores it would occur occasionally that an adjustment to the working frequency would not be possible.

Thus, the coil should be produced as a separate unit to be inserted on the core, and it is important that the coil has a rather close fit on the core. It would be possible to wind the coil on a very thin carrier tube, but with the invention it has been found that because of the relatively large wire thickness, e.g. 0.6 mm, it is also possible to produce a self carrying coil, viz. by coiling the wire and heating the coil for melting together the insulation coatings of the

respective neighboring windings. If the coils are wound with an inner diameter of 9,5 mm they will be well suited for use on core rods of a standard diameter ranging between 9.2 and 9.4 mm.

The invention, which is defined in the appended claims, will now be described in more detail with reference to the drawing, in which: Fig. 1 is a perspective view of the elements of a marker according to the invention,

Fig. 2 is a fragmentary view of a coil therein, and

Fig. 3 is a schematic view illustrating the adjustment of a coil.

In Fig. 1 is shown a marker housing 2 shaped as a simple cutting of a plastic pipe, e.g. having inner and outer diameters of 19 and 20 mm, respectively. By 4 is designated a ferrite core, on which there is mounted a coil 6 connected with a condenser 8. The coil is secured to the core by means of adhesive tape 10.

The unit 4-10 is introduced into the tube 2, whereafter the latter is cast out with a suitable moulding mass, e.g. polyurethane. Perforated collar spacers 12 can be used for centering of the core.

The rod 4 is produced by breaking a ferrite core of a standard length of 20 cm at the middle thereof, upon a kerf being made at that place.

As shown in Fig. 2 the coil 6 is wound on a mandrel 14, which is slightly thicker than the core 4. In the left hand side of the Figure the coiled windings 16 are shown with their associated insulating coating 18.

Upon the coiling of the wire in one layer current is applied to the coil for heating the insulation coating 18 for making it melt together as shown in the right hand side of the Figure. Thereafter the coil can be drawn off as a self-carrying unit.

As shown in Fig. 3 the coil 6 is mounted on a core member 4 placed next to a search detector 20 operating

on the frequency, to which the marker shall be tuned. The condenser 8 and the number of windings of the coil are beforehand adapted to an 'average correct' condition, and the operator may then, by displacing the coil axially on the core, find the coil position by which the particular core gives rise to a maximum reading on a measuring instrument 22 of the detector 20. The coil is fixed in that position, e.g. simply with a piece of adhesive tape 10, whereafter the unit is ready for being cast in in a tube casing 2.

Preferably there is used in or for the coil a wire thickness of 0.6 mm, which is more than required for the electrical function, but a resulting good stiffness and robustness of the coil will be achieved, and the soldering connection with the condenser will be facilitated. Only it should be ensured that the number of windings sufficient for the marker to be operative, given the thickness of the ferrite core, will not amount to a coil length that spoils the adjustment possibilities, when the windings are placed in one or perhaps only two layers, confer the wording of claim 1. In the above example it is satisfactory when the coil has a length of 4-6 cm on a 9 mm core having a length of 10 cm. It would be possible to select a slightly thinner wire to thereby shorten the coil and even the core, but with a maintained or preferred core length of 10 cm there will normally be a sufficient free length of the core for the said overdimensioned wire to be used.

C L A I M S :

1. A rod shaped marker of the electromagnetic resonance type, having a cylindrical housing of a dielectric material and a ferrite core mounted in said housing, this core over a part of its length being provided with an electrical coil connected to a condenser, characterized in that the coil is a one-layer coil and that the ferrite core has a thickness sufficient to condition that the marker can be operative at the desired resonance frequency with the use of this one-layer coil, which has a length of at most 75% of the length of the core and is mounted at such a place of the core, at which the marker is thereby adjusted to the desired resonance frequency.

2. A marker according to claim 1, characterized in that the ferrite core has a thickness of approximately 9 mm and a length of approximately 10 cm, while a surrounding tubular housing has an outer diameter of 20 mm or slightly therebelow.

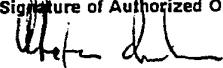
3. A method of manufacturing a marker of the electrical resonance type, whereby a coil on a ferrite core is adjusted to the required resonance frequency, subjected to control measurements, whereafter the core and coil unit is mounted in an outer casing, characterized in that the adjustment is effected by axially displacing the coil, preferably a prefabricated air coil, on the core until a maximum reading is obtained by the control measurement, the coil then being fixed in that position during and after the mounting in the exterior casing.

4. A method according to claim 3, characterized in that the coil is provided as a separate, self carrying

unit, which is introduceable onto the core with a narrow fit, preferably in a condition by which the insulation layers of the coil windings are joined by melting or otherwise, without the use of any inner carrier cylinder.

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK 91/00246

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: G 01 C 15/04, G 01 V 3/12		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC5	G 01 C; G 01 V; G 01 S; H 01 Q; H 03 H; H 04 B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched ⁸		
SE,DK,FI,NO classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	WO, A1, 8401025 (EBINGER, K.) 15 March 1984, see page 3, line 1 - page 4, line 26; page 9, line 15 - page 10, line 1; claims 17-19 --	1-4
A	WO, A1, 8301306 (PETERSEN, W.) 14 April 1983, Mentioned in the description -- -----	1-4
* Special categories of cited documents:¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
15th January 1992	1992 -01- 16	
International Searching Authority	Signature of Authorized Officer	
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**ANNEX TO THE INTERNATIONAL SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 30/11/91
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
WO-A1- 8401025	84-03-15	AU-D-	2037283	84-03-29
		DE-A-C-	3231870	84-03-08
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