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6 CYLINDRICAL RADially SHRINKABLE SLEEVE FOR AN
7 ELECTRICAL CABLE AND COMPOSITION THEREOF
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10 Field of the Invention
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12 The invention refers to a cylindrical radially
13 shrinkable sleeve for enclosing a connection or an end
14 termination of an electrical cable.
15

16 Background of the Invention
17

18 When making cable splices or cable end
19 terminations, it is necessary to expose the conductor
20 of the cable or the cable core. It is common to use
21 radially shrinkable sleeves to enclose a connection or
22 an end termination of an electrical cable. These
23 sleeves consist either of a heat-shrinkable material or
24 of elastic material. In the latter case, they are
25 mechanically retained in an expanded state, usually by
26 a removable core. When the core is removed, the sleeve
27 engages the cable connection or the cable end
28 termination under pressure.

29 Examples of mechanical support cores are disclosed
30 in DE 37 15 915 and EP 0 379 056. The latter
31 publication also discloses a sleeve composed of two
32 layers, with the outer layer having a residual
33 deformation smaller than that of the radially innermost
34 sleeve after the installation of the sleeve. The
35 layers can be manufactured by co-extrusion.

36 Known shrinkable sleeves for the use in the medium
37 voltage range normally have a three-layer structure for
38 electrophysical reasons. The inner layer is provided
39 with field controlling properties. This layer can

1 extend throughout the length of the sleeve as proposed
2 by EP 0 079 118 or, alternatively, consists of three
3 spaced portions, namely a central electrode and two
4 electrodes at the ends as known from DE 39 43 296. The
5 electrodes provide for a uniform distribution of the
6 electrical field in the connection area of the cable
7 conductors and at the ends in the transition area to
8 the cable insulation as well. A second layer, which
9 normally has a larger thickness, serves for insulation
10 purposes, and so it is manufactured from suitable
11 insulation material. An outer layer of semi-conductive
12 material serves for the necessary shielding effect.

13 Sleeves having cylindrical layers can be molded by
14 extrusion or injection molding. In the latter method,
15 the layers are molded by successive injection molding
16 and adhered to each other thereby. Co-extrusion of the
17 sleeve according to the DE 39 43 296 is not possible.
18 Rather, the electrodes have to be manufactured by
19 injection molding.

20 From US 4,390,745, a cylindrical sleeve has become
21 known composed of two separate sleeve portions of heat-
22 shrinkable material. The first or inner sleeve portion
23 has an insulating layer, a dielectric portion at least
24 at one extremity of the sleeve, and a conductive
25 portion spaced from the dielectric portion provided at
26 the inner side of the insulating layer. The second or
27 outer sleeve portion includes an insulating layer and a
28 semi-conductive layer provided at the outer side
29 thereof. The dielectric layer at the inner side and
30 the conductive portion are provided to effect a
31 refractive field control, i.e., to make the field
32 distribution relatively uniform in order to build up
33 electrophysical conditions similar to that of the
34 cable.

35 The semi-conductive inner layer or the electrodes
36 of the sleeve according to DE 39 43 296 consist of a
37 suitable field controlling material which according to
38 DE 34 12 029 may include a permanent flexible

1 dielectric basic material into which a finely divided
2 effective substance is mixed which may consist of dust-
3 fine particles of an electrically polarizable material
4 of low electrical conductivity. For example, carbon
5 black may be used as effective substance. Further, an
6 additional effective substance is used which is
7 metallic conductive. As to this, microspheres having a
8 diameter of at least 2 μm are proposed. The
9 microspheres are at least surface-conductive and may
10 for example consist of aluminum. With such a field
11 controlling material, a relative dielectric constant ϵ_r
12 of 30 to 300 is achieved. Such a field controlling
13 material, therefore, is particularly suited for sleeves
14 which are used with high voltage cables.

15 US 4,547,312 discloses an elastomeric electrically
16 conductive mass which is composed of an elastomer and
17 metallic coated microspheres mixed into the elastomer
18 and having a diameter of 5 μm . The microspheres are
19 added in great quantity. The substance thus achieved
20 serves as a coating of articles in order for make their
21 surface conductive.

22 From DE 27 30 555 it has become known to add 30 to
23 70% by volume glass spheres having a diameter of
24 between 0.1 to 5 mm to insulating masses for electrical
25 cables. The glass spheres serve to reduce the content
26 of more expensive insulating material, e.g. plastic
27 material.

28 From EP 0 189 720, it has become known to add
29 hollow microspheres to a silicone elastomer or a
30 silicone resin for thermal insulation purposes.

31 From DE 32 26 380, it has become known to place a
32 plurality of electrodes forming spheres into an
33 insulating material for enclosing a cable connection or
34 a cable and termination. To this purpose, layers of
35 insulating material are provided with conductive
36 spheres in the diameter range of 0.5 to 10 μm . By this

1 method the insulating material obtains field
2 controlling properties.

3 As a consequence of the relatively large spheres
4 the mass obtained cannot be considered homogeneous. It
5 is further relatively difficult to uniformly distribute
6 the relatively large spheres in the elastomeric matrix.
7 Therefore, in the mentioned publication it is explained
8 to use strips of plastic material into which the
9 spheres are uniformly embedded. Thereafter, the strips
10 are wrapped around the cable connection. This method
11 is relatively expensive and does not lead to the
12 desired electrophysical properties in view of the field
13 control. Further, the danger exists that the
14 insulation properties suffer.

15 From US 5,232,775, it has become known to add
16 metal coated spheres, e.g. glass bubbles, to a
17 polymeric resin in order to achieve a semi-conductive,
18 static dissipative composition.

19 From US 4,618,325 and US 4,579,882, it has become
20 known to add metal coated glass spheres with the
21 diameter range between 5 to 100 μm to the adhesive
22 layer of a pressure-sensitive adhesive tape in order to
23 influence the optical properties of the tape.

24 US 4,579,882 teaches methods of making spheres and
25 calculating the thickness of coatings. From this
26 patent it has become known to mix a polymer as matrix
27 material with metal coated powder of an inorganic
28 material. The substance thus achieved serves for the
29 coating of articles in order to obtain a shielding
30 against electromagnetic waves. All at last described
31 compositions do not include electrically insulating
32 properties to make them suitable for higher voltages
33 applications.

34

35 Summary of the Invention

36

1 The invention provides a radially shrinkable
2 sleeve for the enclosure of a connection or an end
3 termination of a cable which can be manufactured
4 inexpensively and is particularly suited for medium
5 voltages up to 15 kV.

6 A sleeve according to one aspect of the invention
7 consists of a radial inner layer of a homogeneous
8 material having a relative dielectric constant which is
9 significantly larger than that of the insulation of the
10 cable.

11 Normally, field control material has a low
12 dielectric strength. On the other hand, insulation
13 material has no
14 field controlling properties. The invention
15 contemplates that a compromise can be achieved for both
16 materials. If the innermost layer of a sleeve is
17 provided with a dielectric constant which is larger
18 than that of the insulation of the cable, it is
19 possible to obtain a limited field controlling effect
20 although this layer is an electrical insulator. In
21 particular, in the medium voltage range up to 15 kV,
22 the mentioned field controlling effect can be
23 satisfactory. Therefore, a sleeve for enclosing a cable
24 connection or a cable end termination needs only two
25 layers, namely the already described field controlling
26 and insulating layer and the outer shielding layer.
27 Such a sleeve can be manufactured simply by co-
28 extrusion.

29 Since for the inner central area of the sleeve
30 according to the invention no electrode is provided, it
31 may be necessary to wrap the conductor connection with,
32 for example, a semi-conductive mastic tape having at
33 relatively large dielectric constant in order to
34 equalize the potential in the area of the connection.
35 It is understood that also other known means could be
36 used to arrive at the intended purpose, such as by
37 means of a void-free medium having a relatively large
38 dielectric constant or by means of a Faraday cage.

1 The sleeve according to the invention can be
2 easily manufactured and has the further advantage that
3 no particular adaptation to the length of a cable
4 connection is necessary, rather, the sleeve according
5 to the invention may have any length. The sleeve
6 according to the invention can be reliably used for a
7 relatively broad medium voltage range and for different
8 sizes and types. The installation taken place without
9 tools. The sleeve according to the invention is
10 particularly suited in connection with mechanical
11 support means, particularly a support core as disclosed
12 in the DE 37 15 915.

13 According to the invention, the relative
14 dielectric constant of the innermost layer is 3 or
15 larger than 3. Preferably, it is between 3 and 10.

16 As already mentioned, only two layers are
17 necessary for the sleeve. If applied to a higher
18 medium voltage range, it may be appropriate to provide
19 an additional insulating layer beyond what the
20 insulating innermost layer provides, i.e. the field
21 controlling effect, and the outer shielding layer.
22 Also such sleeve structure can be molded by extrusion.

23 Various methods are conceivable to provide an
24 insulating material with a larger relative dielectric
25 constant without reducing the dielectric strength too
26 much. According to an embodiment of the invention, a
27 matrix of a dielectric plastic material and a content
28 of microspheres is provided with the microspheres
29 conductive totally or only at the surface thereof,
30 having a diameter distribution of between 10 and 500 μm
31 and being uniformly distributed in the matrix material,
32 the compound thus achieved having a relative dielectric
33 constant ≥ 3 and a dielectric strength of at least 5
34 kV/mm. Silicone rubber may be used as the matrix
35 material, in particular liquid silicone rubber.
36 However, other matrix materials can be used, for
37 example, acrylester rubber (ANM), cellulose acetate

1 (CA), epoxide (EP), nitrile rubber (NBR/NCR), polyamide
2 (PA), polyacrylate (PAR), polycarbonate (PC), polyimide
3 (PI), styrenebutadiene rubber (SBR), silicone (SI) or
4 vinylacetate (VAC). It is essential that the matrix
5 material have reasonable molding properties and the
6 ability to be molded by known molding processes such as
7 extrusion or injection molding. It is further
8 essential that the structure or constitution of the
9 matrix material be such that the spheres are not
10 crushed or deteriorated by such molding process, that
11 is, that the material have a relatively low viscosity.

12 The diameter range of the spheres is between 10
13 and 500 μm . Preferably, according to an embodiment of
14 the invention, the diameter distribution is between 10
15 and 90 μm and preferably between 30 and 60 μm . These
16 small spheres can be simply processed with conventional
17 plastic molding methods and effect a satisfactory
18 homogeneous distribution in the molded article. The
19 relative dielectric constant obtained with this mass is
20 ≥ 3 , with the dielectric strength being at least 5
21 kV/mm.

22 The microspheres can be made of metal.
23 Preferably, glass spheres are used, particularly hollow
24 glass spheres or bubbles as for example known from
25 "ScotchliteTM Glass Bubbles Hollow Micro Glass Spheres"
26 product information and specification of 3M Company,
27 St. Paul, Minnesota of January 1, 1993. They are made
28 of low alkali borosilicate glass and are chemically
29 inactive. The bubbles have a size distribution of 96%
30 in the range of 20 to 120 μm and of 60% in the range of
31 40 to 80 μm . If metal spheres are used, electrical
32 conductivity is automatically available. If, however,
33 glass spheres are used, a surface coating with a metal
34 is mandatory. The coating may consist of for example,
35 aluminum, nickel, silver, or the like. The metallic
36 coating can be as thin as practical since significant

1 current does not flow. Therefore, the coating may
2 have, for example, a thickness of 0.001 μm .

3 According to a further embodiment of the
4 invention, it may be appropriate to provide the spheres
5 with an insulating coating. This applies to metal
6 spheres and to metal coated glass spheres as well. In
7 this case, touching of some spheres is not
8 substantially injurious relative to the desired
9 insulating effect. Such a coating may be very thin,
10 for example 0.0004 μm . The preferred material for this
11 coating is to be selected such that it is compatible
12 with the metal or the metal coating in order to avoid a
13 chemical reaction and to provide a sufficient adhesive
14 capacity. For example, aluminum can be used for the
15 metal coating and aluminum sub oxide as insulating
16 coating. The coating of the non-conductive glass
17 spheres with a metal can be carried out by conventional
18 technologies, e.g. the sputter deposition process.

19 It has been found through experimentation that the
20 system works both with spheres having the additional
21 insulative oxide layer as well as with spheres which
22 have the bare metal coating. The reason for this is
23 that the spheres under normal circumstances are
24 insulated from each other by the matrix material. Only
25 very occasionally does contact between spheres occur
26 which changes the electrical properties and then by
27 only an insignificant amount. The additional coating
28 may, however, be advantageous under certain
29 circumstances. For example, it has been observed that
30 during the molding process a higher concentration of
31 spheres has been observed at corners of the mold cavity
32 as a consequence of material flow behavior.

33 In particular with the use of glass spheres, it is
34 essential that they are not crushed by the molding
35 process. Therefore, liquid silicone rubber may be
36 advantageously used because its viscosity is relatively
37 low. A high viscosity would lead to a crushing of the

1 spheres and further prevent the spheres from being
2 uniformly distributed during the mixing process.

3
4 Brief Description of the Drawings

5
6 Embodiments of the invention will be subsequently
7 described at more detail in connection with drawings,
8 wherein like numbers refer to like parts in the several
9 views, and wherein:

10 Figure 1 is a graph of the specific resistivity,
11 the dielectric strength, the relative dielectric
12 constant and the dissipation factor relative to the
13 volume content of glass bubbles in its matrix;

14 Figure 2 is a perspective view, with a portion
15 cut away, of a first embodiment of a shrinkable sleeve
16 according to the invention;

17 Figure 3 is a perspective view similar to Figure
18 2, and illustrates the sleeve of Figure 2 after the
19 installation on a cable connection;

20 Figure 4 shows a second embodiment according to
21 the invention;

22 Figure 5 is a graph of the dielectric constant
23 versus size distribution of glass bubbles in its
24 matrix;

25 Figure 6 is a graph of is a graph of the
26 dielectric strength versus size distribution of glass
27 bubbles in its matrix;

28 Figure 7 is a graph of dielectric constant versus
29 percent weight of the glass bubbles; and

30 Figure 8 is a graph of dielectric strength versus
31 percent weight of the glass bubbles along with the
32 average dielectric constant of the glass bubbles of
33 Figure 7.

34
35 Description Of Preferred Embodiments

36
37 An elastic sleeve 10 is placed on a supporting
38 core 12 as already known. Sleeve 10 comprises an inner

1 layer 14 and an outer layer 16 which, for example, are
2 made by co-extrusion. The inner layer 14 is of an
3 insulating material which also has a dielectric
4 constant of ≥ 3 . The outer layer 16 is made of a
5 suitable semi-conductive material.

6 In Figure 3 it is shown how sleeve 10 is placed on
7 a cable connection. The cables 18, 20 include
8 conductors 22, 24 which are interconnected through a
9 connector 26 in a conventional manner.

10 It can be further seen in Figure 3 that the
11 connector area is wrapped by a semi-conductive mastic
12 tape 28 in order to achieve a field equalizing effect
13 in this area. As an alternative to the mastic tape 28,
14 the sleeve 10 may be provided with a central electrode
15 of a conductive or semi-conductive material which has
16 been incorporated into the main body. Such an
17 electrode is described in German patent no. P 39 43
18 296.3, which is hereby incorporated by reference.

19 The thickness of the cable insulation is 4.0 mm
20 for a 10 kV cable and 4.5 mm for a 15 kV cable. The
21 following values are achieved for a sleeve 10 according
22 to Figure 2:

23
24 Relative dielectric constant of inner layer 14: 3
25 Thickness of the inner layer 14: 8.5
26 mm
27 Dielectric strength of inner layer 14: 20
28 kV/mm
29 Dissipation factor:
30 0.0001
31

32 The graph of Figure 1 represents the relations for
33 an insulating mass used for the inner layer 14 of a
34 sleeve of
35 Figure 2. Liquid silicone rubber is matrix material is
36 mixed with metallic coated glass bubbles. In Figure 1,
37 the abscissa represents the volume percent of glass

1 bubbles in the matrix and the ordinate dielectric
 2 properties of the matrix. The line marked with the
 3 symbol "X" represents volume resistivity in units of
 4 Ωcm times 10^{14} , the line marked with filled circles
 5 represents dielectric strength in units of kV/mm, the
 6 line marked with filled triangles represents the
 7 dielectric constant ϵ_r divided by 10, and the line
 8 marked with filled squares represents the dissipation
 9 factor $\tan \delta$ divided by 1000. The specific gravity of
 10 the glass bubbles is 0.6. Its hydrostatic compression
 11 strength is 7000 N/cm^2 . The size distribution of the
 12 spheres is as follows:

14 Sieve Size (μm)	Percent Passing Through Sieve
15 88	100
16 62	93.7
17 44	73.7
18 31	50.5
19 22	30.5
20 16	15.8
21 11	7.4
22 7.8	2.1
23 5.5	0.0

24
 25 The glass bubbles are coated with aluminum, with
 26 the coating having a thickness of 100 Angstroms while
 27 the insulating layer of aluminum oxide coated on the
 28 metallic coating has a thickness of 40 Angstroms. The
 29 graph of Figure 1 reveals that the specific resistivity
 30 is constant above 2% by volume and has a value in the
 31 order of $6 \times 10^{13} \Omega\text{cm}$. The dielectric strength in the
 32 range of 18 kV/mm which is particularly satisfactory
 33 for the medium voltage range. The dissipation factor
 34 is about 0.0001. At a volume content of 2%, the
 35 relative dielectric constant is somewhat above 3 while
 36 it is 4 at a volume content of 10%.

1 The above mentioned values for the inner layer 14
2 of sleeve 10 of Figure 2 are therefore achieved at a
3 volume content of glass bubbles of 2%.

4 The sleeve 10a Of Figure 4 differs from that. of
5 Figure 2 in that an additional insulating layer 30 is
6 located between the insulating inner layer 14 and a
7 shielding layer 16. Sleeve 10a can be made by co-
8 extrusion or by a successive injection molding. The
9 second insulating layer 30 can be made of a
10 conventional flexible insulating material, e.g.
11 silicone rubber or liquid silicone rubber. The inner
12 layer 14 corresponds to that of Figure 2.

13 Sleeve 10 of Figure 2 is suited for the medium
14 voltage range up to 15 kV, while the sleeve of Figure 4
15 can be used for medium voltages above 15 kV.

16 In addition to the above mentioned material for
17 the layers 14 of Figs. 2 and 4, the following
18 compositions can be provided:

19

- 20 (1) 100 parts methylvinyl silicone rubber (HDU)
21 (e.g. silicone rubber R 420/40 U of the German
22 company Wacker)
23 10 parts carbon black N 765
24 0.9 parts dicumyl peroxide

25

26 The following electrophysical properties are achieved:

27

28 Relative dielectric constant ϵ_r = 4.6
29 Resistivity: = $3 \times 10^{14} \Omega\text{cm}$
30 Dielectric strength: = 10 kV/mm

31

- 32 (2) Substances and parts as mentioned above, however
33 carbon black type N 683 is used

34

35 The following electrophysical properties are achieved:

36

37 Relative dielectric constant ϵ_r = 3.5

1 Resistivity: = $5 \times 10^{14} \Omega\text{cm}$
2 Dielectric strength: = 12 kV/mm

3

4 It has been found that it is possible to optimize
5 the electrical properties of the inner layer according
6 to the requirements of the specific intended use. The
7 main properties, namely the relative dielectric
8 constant and the dielectric strength, can be varied
9 within certain limits by selecting the diameter range
10 of the glass bubbles, the thickness of the aluminum
11 coating and the concentration of the glass bubbles in
12 the matrix material.

13 This can be best seen from the Figures 5 through
14 8. These result from a set of experiments as described
15 below which allowed optimization of bubble properties.
16 In a specific set of experiments the glass bubbles
17 referred to in the description of Figure 1 were used
18 with the following differences:

19 Glass bubbles were obtained having different
20 thickness of the aluminum coating, namely, 23.6
21 Angstroms, 44.3 Angstroms, 63.8 Angstroms, 132.2
22 Angstroms and 160.0 Angstroms.

23 Furthermore, these glass bubbles were sieved
24 yielding the following diameters, 0-32 microns, 32-50
25 microns, 50-80 microns and 80-125 microns.

26 The samples were prepared in the following manner:

27 Mixing 200 grams of material - liquid silicone
28 rubber no. 2030 parts A and B 1:1 plus the calculated
29 quantity of glass bubbles - with a hand-held kneader
30 for 5 minutes. The mixed compound was evacuated at 50
31 mbars for 30 minutes and press-molded immediately
32 afterwards. Molding was done by filling the mix into a
33 press-mold to 60° C, transferring the mold into the
34 preheated press and molding for 10 minutes at 145° C.

35 The slabs were then post cured for 4 hours at 200°
36 C.

1 Electrical properties resistivity, dissipation
2 factor, relative dielectric constant and dielectric
3 strength were measured without silver paint according
4 to VDE (Verband Deutscher Elektrotechniker) 0303 Part
5 4. The property values were averages of three slabs.

6 Figure 5 shows the dependence of the dielectric
7 constant on the size distribution of the glass bubbles.
8 The abscissa is sieve mesh in microns and the ordinate
9 is dielectric constant. The line marked with filled
10 squares represents an aluminum coating on the glass
11 bubbles of 23.6 Angstroms, the filled diamonds 44.3
12 Angstroms, the filled triangles 63.8 Angstroms, the
13 open squares 123.2 Angstroms, the open diamonds 160
14 Angstroms, and the open triangles 160 Angstroms
15 unsieved. The measurement points were placed on the
16 upper limit of the sieving range (e.g. the values at 32
17 microns represent glass bubbles in the range of 0-32
18 microns, etc.) It can be seen that the dielectric
19 constant increases up to the range of 50-80 microns
20 with a weak dependence on the thickness of the aluminum
21 coating. For comparative reasons the value for
22 unsieved glass bubbles with a coating thickness of 160
23 Angstroms is indicated which essentially corresponds to
24 the material used in Figure 1.

25 Furthermore, it can be seen that the coating
26 thickness should not be too small and preferably be in
27 the range of 40-60 Angstroms.

28 Figure 6 shows the corresponding relationship for
29 the dielectric strength. The abscissa represents sieve
30 mesh in microns and the ordinate dielectric strength in
31 kV/mm. The line marked with filled squares represents
32 an aluminum coating on the glass bubbles of 23.6
33 Angstroms, the filled diamonds 44.3 Angstroms, the
34 filled triangles 63.8 Angstroms, the open squares 123.2
35 Angstroms, the open diamonds 160 Angstroms, and the
36 open triangles 160 Angstroms unsieved. Here the
37 opposite trend can be observed, namely a reduction when
38 moving to larger particles. However, a stable

1 situation is reached when using glass bubbles ranging
2 above to 80 microns. The influence of the coating
3 thickness is also moving in the opposite direction
4 yielding the best values at 23.6 Angstroms. Also here
5 the unsieved fraction is indicated.

6 In Figure 7, the abscissa represents percent
7 weight of glass bubbles in the matrix and the ordinate
8 dielectric constant. The line marked with filled
9 squares represents an aluminum coating on the glass
10 bubbles of 23.6 Angstroms, the filled diamonds 44.3
11 Angstroms, the filled triangles 63.8 Angstroms, the
12 open squares 123.2 Angstroms, and the open diamonds 160
13 Angstroms. Figure 7 demonstrates that the dependence
14 of the coating thickness of the glass bubbles is rather
15 weak and that the main determining factor for the
16 dielectric constant is the percent weight of the glass
17 bubbles.

18 In Figure 8 the abscissa represents percent weight
19 of glass bubbles in the matrix, the ordinate on the
20 left side represents dielectric constant, and the
21 ordinate on the right side represents dielectric
22 strength in kV/mm. The line marked with filled squares
23 represents an aluminum coating on the glass bubbles of
24 23.6 Angstroms, the filled diamonds 44.3 Angstroms, the
25 filled triangles 63.8 Angstroms, the open squares 123.2
26 Angstroms, the open diamonds 160 Angstroms, and the
27 open triangles the average value of dielectric constant
28 taken from Figure 7 for comparison. Figure 8 on the
29 other hand shows that this is not the case for the
30 dependence of the dielectric strength, the values of
31 which are marked on the right side of the diagram.
32 Here it can be more clearly seen that the smaller the
33 aluminum coating thickness is, the better the
34 dielectric strength which can be obtained.

35 Using experimental methods of this type it is
36 possible to achieve the required optimization. For
37 example, using glass bubbles of the sieving range of
38 32-50 microns and a coating thickness of 44.3 Angstroms

1 and a percentage weight of 5% a relative dielectric
2 constant of 3.85 and a dielectric strength of 16.5
3 kV/mm is obtained. Alternatively, when choosing the
4 same sieve size of the glass bubbles, namely 32-50
5 microns, but an aluminum coating of 23.6 Angstroms and
6 a percentage weight of 3%, the dielectric constant
7 would be reduced to 3.45 and the dielectric strength
8 would increase to 21 kV/mm.



1 We Claim:

2

3 1. Cylindrical radially shrinkable sleeve for
4 enclosing a connection or an end termination of an
5 electrical cable, in particular for a medium voltage
6 cable, having insulation surrounded by a shielding
7 layer, said sleeve comprising an outer shielding layer
8 of semi-conductive material and at least an insulation
9 layer on the inner side of said shielding layer, with
10 the unit of said cylindrical layers made of permanent
11 flexible material adapted to be retained in a radially
12 expanded state by mechanical support means,
13 characterized in that the radially innermost layer is
14 of a homogeneous material having a relative dielectric
15 constant which is significantly larger than that of
16 said insulation of said cable.

17

18 2. The sleeve of claim 1, wherein the relative
19 dielectric constant of the innermost layer is ≥ 3 .

20

21 3. The sleeve of claim 1 or 2, wherein a single
22 inner layer is provided.

23

24 4. The sleeve of claim 1, wherein said inner
25 layer is comprised of a matrix of dielectric plastic
26 material and a content of microspheres conductive at
27 least at the surface thereof and having a diameter
28 distribution of 10 to 500 μm , said microspheres being
29 uniformly distributed in said matrix material, with the
30 mixture having:

31 a) a relative dielectric constant > 3 and

32 b) a dielectric strength of at least 5

33 kV/mm.

34

35 5. The sleeve of claim 4, wherein silicone
36 rubber is said matrix material.

37



1 6. The sleeve of claim 4 or 5, wherein the
2 diameters of said spheres differ from each other not
3 more than one order of magnitude.

4
5 7. The sleeve of claim 6, wherein the diameter
6 distribution of said microspheres is between 10 and
7 90 μ m, preferably between 30 and 60 μ m.

8
9 8. The sleeve of claim 4, wherein said
10 microspheres are metal spheres.

11
12 9. The sleeve of claim 4, wherein said
13 microspheres are said glass spheres being coated with a
14 metal.

15
16 10. The sleeve of claim 9, wherein said coating
17 is of aluminum, nickel, silver or the like.

18
19 11. The sleeve of claim 4, wherein said spheres
20 are coated with a thin insulating layer, preferably by
21 aluminum sub oxide.

22
23 12. The sleeve of claim 9 or 10, wherein the
24 thickness of said coating is about 0.001 μ m.

25
26 13. The sleeve of claim 11, wherein the thickness
27 of said insulating layer is about 0.0004 μ m.

28
29 14. The sleeve of claim 4, wherein the content of
30 said microspheres is between 2 and 12% by volume,
31 relative to said matrix material.

32
33 15. The sleeve of claim 4, wherein the relative
34 dielectric constant is between 3 and 10.

35
36 16. The sleeve of claim 4, wherein the dielectric
37 strength is at least 10 kV/mm.



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17. The sleeve of claim 4, wherein the dissipation factor is less than 0.01.

18. The sleeve of claim 1, wherein said innermost layer is methylvinyl silicone rubber.

19. Electrically insulating, moldable mass having field control properties, in particular for the use in the medium voltage range, comprising a matrix of dielectric plastic material and a percentile share of microspheres electrically conductive either totally or at the outer surface thereof and having a diameter between 10 and 500 μm , said microspheres being uniformly mixed into said matrix material, with said compound having

a) a dielectric constant equal to or larger than 3 and

b) a dielectric strength of at least 5 kV/mm.

20. The mass of claim 19, wherein the relative dielectric constant is between 3 and 10, preferably between 3 and 4.

21. The mass of Claim 19, wherein the dielectric strength is at least 10 kV/mm.

22. The mass of Claim 19, wherein the dissipation factor is < 0.01 , preferably < 0.001 .

23. The mass of claim 19, wherein the diameter of said spheres is not differing more than one order of magnitude.

24. The mass of claim 19, wherein the diameter distribution of said spheres is between 10 and 90 μm , preferably between 30 and 60 μm .

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25. The mass of claim 19, wherein metallic spheres are used or metal-coated glass spheres, preferably hollow glass spheres (glass bubbles).

26. The mass of claim 25, wherein said coating consists of aluminum nickel, silver or the like, preferably with a thickness of about 0.001 μm .

27. The mass of claim 26, wherein said spheres are coated with a thin insulating layer, preferably with aluminum oxide, preferably with a thickness of about 0.0004 μm .

28. The mass of claim 19, wherein the content of said microspheres is between 2 and 20% by volume relative to said matrix material.

29. The mass of claim 19, wherein silicone rubber is used as matrix material.



* C L M S *