

PATENT SPECIFICATION

(11)

1 583 955

1 583 955

(21) Application No. 1801/77 (22) Filed 17 Jan. 1977

(23) Complete Specification filed 16 Jan. 1978

(44) Complete Specification published 4 Feb. 1981

(51) INT. CL.³ H01B 7/28

(52) Index at acceptance

HIA 12 1C 2E3D2 2E4B1 2E4B2 6S

(72) Inventors FRANK GORDON TAYLOR,

THOMAS SULLIVAN and

JAMES EDWARD BRADDOCK



(54) ELECTRIC CABLES

(71) We, BICC LIMITED, a British Company, of 21 Bloomsbury Street, London WC1B 3QN, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to insulated electric cables. It is a requirement for certain classes of cable, such as those used in fire alarm and emergency lighting circuits, to remain functional for a significant length of time, preferably several hours, after they have been damaged by a fire. Various cables have been designed to meet this requirement, including some with polymeric-based insulation and sheathing. Usually the insulation has been of a silicone rubber composition, which leaves an electrically insulating residue of silica when burnt. It has however proved difficult to ensure that the integrity of the sheathing is maintained during and after exposure to fire conditions to the extent necessary to prevent loss of the powdery residue of the insulation, without at the same time reducing the flexibility of the cable to an undesirable degree.

The cable in accordance with the invention includes two or more metallic conductors insulated from one another by silicone rubber or other polymeric-based material that leaves an electrically-insulating residue on combustion. Usually the insulation will be in the form of a concentric layer on one or more of the conductors; one conductor will often, but not always, be left bare for use as an earth conductor; if the number of conductors is large more than one bare conductor could be included, but this would be an unusual arrangement. The insulated conductors may be helically laid up, or they could be assembled in other ways, for example with the conductors all straight and parallel.

The insulated conductor assembly is enclosed, in accordance with the invention, in a composite sheath comprising an inner bedding layer of a resilient polymeric-based

electrically insulating material, and an outer layer of flexible metal. The cable may also include an outermost layer of insulating material of low flamability.

The bedding layer is preferably extruded, but could if desired be formed by a tape applied helically or longitudinally to the insulated conductor assembly.

The bedding layer is preferably of a material that leaves an insulating residue on combustion, such as a silicone rubber. Alternatively however it may be of other flame-ratardant, low-smoke compositions, for example an alkylene homo- or copolymer with a high proportion of a mineral filler. Two suitable formulations of the latter kind comprise:

PARTS BY WEIGHT

	Formula- tion 1	Formula- tion 2
Ethylene-propylene rubber	22	—
60% Ethylene-40% Vinyl acetate copolymer	—	24
Alumina trihydrate (Hydral 310) (Nominal particle size 1µm)	62	70
Plasticisers: Polyisobutylene	7.7	—
Paraffin wax	3.3	—
Processing aid: Stearic acid	—	2
Curing agents (optional) & Antioxidants	1 up to 5	2 up to 4

70

75

80

85

90

95

100

105

110

115

120

125

130

135

140

145

150

155

160

165

170

175

180

185

190

195

200

205

210

215

220

225

230

235

240

245

250

255

260

265

270

275

280

285

290

295

300

305

310

315

320

325

330

335

340

345

350

355

360

365

370

375

380

385

390

395

400

405

410

415

420

425

430

435

440

445

450

455

460

465

470

475

480

485

490

495

500

505

510

515

520

525

530

535

540

545

550

555

560

565

570

575

580

585

590

595

600

605

610

615

620

625

630

635

640

645

650

655

660

665

670

675

680

685

690

695

700

705

710

715

720

725

730

735

740

745

750

755

760

765

770

775

780

785

790

795

800

805

810

815

820

825

830

835

840

845

850

855

860

865

870

875

880

885

890

895

900

905

910

915

920

925

930

935

940

945

950

955

960

965

970

975

980

985

990

995

1000

1005

1010

1015

1020

1025

1030

1035

1040

1045

1050

1055

1060

1065

1070

1075

1080

1085

1090

1095

1100

1105

1110

1115

1120

1125

1130

1135

1140

1145

1150

1155

1160

1165

1170

1175

1180

1185

1190

1195

1200

1205

1210

1215

1220

1225

1230

1235

1240

1245

1250

1255

1260

1265

1270

1275

1280

1285

1290

1295

1300

1305

1310

1315

1320

1325

1330

1335

1

be applied tightly enough to ensure continuous effective contact between the metal layer and the auxiliary wire conductor.

When the metal layer is of foil, the insulating outermost layer should in most cases be used, and one very suitable material for this layer is a plasticised PVC (polyvinyl chloride) compound, preferably formulated to enhance its flame-retardant properties.

Hard grades of compound are preferred. Formulations in accordance with our British Patent No. 1418027 are preferred, but other flame-retardant grades, including the conventional type having calcium carbonate as filler and antimony trioxide as the principal flame-retardant additive, can be used. In some cases the use of basic fillers of very high specific area (small particle size) may be desirable as it reduces the amount of hydrogen chloride gas and/or hydrochloric acid droplets in the smoke produced if the compound should be burnt. When the foil is enclosed in an outermost layer it is preferably pre-coated on its surface with a polymeric material that promotes adhesion of the outermost layer to the foil. Such a coating preferably covers the whole of the outer surface of the foil, except when an auxiliary conductor is located outside it, when an appropriate area or areas must be left bare.

When the metal layer is of tape, the insulating outermost layer will not usually be needed for mechanical protection, but may be desirable to improve resistance to corrosion. In this case adhesion to the metal layer will not necessarily be of importance, and as alternatives to PVC may be used for example fire-retardant ethylene-propylene rubber compositions (such as the one described above), fire-retardant cross-linked polyethylene (such as the one sold under the trademark "Petrothene"), flame-retardant grades of silicone rubber, or chlorosulphonated polyethylene compounds. The metal layer can be seam-welded if desired.

The metallic conductors are preferably of tinned copper, but bare or nickel-plated copper can be used, as can other metals with sufficiently high conductivity and sufficiently high melting point.

The insulated conductors may be distinguished by any of the conventional ways of marking, e.g. by colouring each differently if the number of conductors is small or by colouring two adjacent conductors in each layer to define an origin and direction for counting the remainder of the layer.

Silicone rubber complying with British Standard 6899-1976 Type E12 is very suitable for the conductor insulation and for the bedding layer of the composite sheath.

If made with suitably-chosen silicone rubber and PVC compounds of the classes indicated, the cable described may comply with the requirements of IEC Publications 331

and 323 (International Electrotechnical Commission), respectively for maintenance of circuit integrity under prescribed fire conditions and for flame retardance.

EXAMPLE

Two wires, each of plain copper wire 1.38 mm in diameter and each insulated with 0.6 mm radial thickness of a conventional silicone rubber formulation, are laid up with a single earth wire of tinned copper also 1.38 mm in diameter. An extruded bedding made of the Type E12 silicone rubber referred to and of 1 mm nominal wall thickness has an external diameter of about 7.4 mm. Over this is applied a metal layer formed by a longitudinally-wrapped aluminium foil, 28 mm wide and 0.15 mm thick, coated on the outside only with a thin layer of PVC; an auxiliary earth conductor of 0.9 mm diameter tinned copper wire is laid under the foil as it is applied. Over the wrapped coated foil is promptly extruded an outermost layer about 0.8 mm thick of a PVC compound containing finely-divided chemically-basic filler.

Attention is drawn to our copending cognate applications 10267/77 (Serial no. 1583956) and 173/78 which claim an electric cable comprising at least one polymeric-insulated conductor, a bedding layer surrounding the conductor and made from a composition comprising a curable alkene homopolymer or copolymer, at least 55% of inert mineral filler, a low smoke plasticiser, a curing agent for the polymer and an antioxidant, and an enclosing sheath of low flammability material.

WHAT WE CLAIM IS:—

1. An electric cable comprising two or more metallic conductors insulated from one another by a polymeric material that leaves an electrically-insulating residue on combustion and enclosed in a composite sheath comprising an inner bedding layer of a resilient polymeric-based electrically insulating material and an outer layer of flexible metal.
2. An electric cable comprising two or more metallic conductors insulated from one another by a polymeric material that leaves an electrically-insulating residue on combustion and enclosed in a composite sheath comprising an inner bedding layer of a resilient polymeric-based electrically insulating material, an outer layer of flexible metal foil, and an outermost layer of insulating material of low flammability.
3. An electric cable as claimed in Claim 2 in which the foil is pre-coated on its surface with a polymeric material that promotes adhesion of the outermost layer to the foil.
4. An electric cable as claimed in Claim 1 in which the outer layer is of metal tape.
5. An electric cable as claimed in Claim 130



be applied tightly enough to ensure continuous effective contact between the metal layer and the auxiliary wire conductor.

When the metal layer is of foil, the insulating outermost layer should in most cases be used, and one very suitable material for this layer is a plasticised PVC (polyvinyl chloride) compound, preferably formulated to enhance its flame-retardant properties. Hard grades of compound are preferred. Formulations in accordance with our British Patent No. 1418027 are preferred, but other flame-retardant grades, including the conventional type having calcium carbonate as filler and antimony trioxide as the principal flame-retardant additive, can be used. In some cases the use of basic fillers of very high specific area (small particle size) may be desirable as it reduces the amount of hydrogen chloride gas and/or hydrochloric acid droplets in the smoke produced if the compound should be burnt. When the foil is enclosed in an outermost layer it is preferably pre-coated on its surface with a polymeric material that promotes adhesion of the outermost layer to the foil. Such a coating preferably covers the whole of the outer surface of the foil, except when an auxiliary conductor is located outside it, when an appropriate area or areas must be left bare.

When the metal layer is of tape, the insulating outermost layer will not usually be needed for mechanical protection, but may be desirable to improve resistance to corrosion. In this case adhesion to the metal layer will not necessarily be of importance, and as alternatives to PVC may be used for example fire-retardant ethylene-propylene rubber compositions (such as the one described above), fire-retardant cross-linked polyethylene (such as the one sold under the trademark "Petrothene"), flame-retardant grades of silicone rubber, or chlorosulphonated polyethylene compounds. The metal layer can be seam-welded if desired.

The metallic conductors are preferably of tinned copper, but bare or nickel-plated copper can be used, as can other metals with sufficiently high conductivity and sufficiently high melting point.

The insulated conductors may be distinguished by any of the conventional ways of marking, e.g. by colouring each differently if the number of conductors is small or by colouring two adjacent conductors in each layer to define an origin and direction for counting the remainder of the layer.

Silicone rubber complying with British Standard 6899-1976 Type E12 is very suitable for the conductor insulation and for the bedding layer of the composite sheath.

If made with suitably-chosen silicone rubber and PVC compounds of the classes indicated, the cable described may comply with the requirements of IEC Publications 331

and 323 (International Electrotechnical Commission), respectively for maintenance of circuit integrity under prescribed fire conditions and for flame retardance.

EXAMPLE

Two wires, each of plain copper wire 1.38 mm in diameter and each insulated with 0.6 mm radial thickness of a conventional silicone rubber formulation, are laid up with a single earth wire of tinned copper also 1.38 mm in diameter. An extruded bedding made of the Type E12 silicone rubber referred to and of 1 mm nominal wall thickness has an external diameter of about 7.4 mm. Over this is applied a metal layer formed by a longitudinally-wrapped aluminium foil, 28 mm wide and 0.15 mm thick, coated on the outside only with a thin layer of PVC; an auxiliary earth conductor of 0.9 mm diameter tinned copper wire is laid under the foil as it is applied. Over the wrapped coated foil is promptly extruded an outermost layer about 0.8 mm thick of a PVC compound containing finely-divided chemically-basic filler.

Attention is drawn to our copending cognate applications 10267/77 (Serial no. 1583956) and 173/78 which claim an electric cable comprising at least one polymeric-insulated conductor, a bedding layer surrounding the conductor and made from a composition comprising a curable alkene homopolymer or copolymer, at least 55% of inert mineral filler, a low smoke plasticiser, a curing agent for the polymer and an antioxidant, and an enclosing sheath of low flammability material.

WHAT WE CLAIM IS:—

1. An electric cable comprising two or more metallic conductors insulated from one another by a polymeric material that leaves an electrically-insulating residue on combustion and enclosed in a composite sheath comprising an inner bedding layer of a resilient polymeric-based electrically insulating material and an outer layer of flexible metal.

2. An electric cable comprising two or more metallic conductors insulated from one another by a polymeric material that leaves an electrically-insulating residue on combustion and enclosed in a composite sheath comprising an inner bedding layer of a resilient polymeric-based electrically insulating material, an outer layer of flexible metal foil, and an outermost layer of insulating material of low flammability.

3. An electric cable as claimed in Claim 2 in which the foil is pre-coated on its surface with a polymeric material that promotes adhesion of the outermost layer to the foil.

4. An electric cable as claimed in Claim 1 in which the outer layer is of metal tape.

5. An electric cable as claimed in Claim 130

- 4 including an outermost layer of insulating material of low flamability.
6. An electric cable as claimed in any one of the preceding claims in which the bedding layer is of a material that leaves an insulating-residue on combustion.
7. An electric cable as claimed in Claim 6 in which the said material is a silicone rubber.
8. An electric cable as claimed in any one of claims 1—5 in which the bedding layer is of a flame-retardant low-smoke composition comprising an alkylene homo- or co-polymer with a high proportion of a mineral filler.
9. An electric cable as claimed in Claim 8 in which the bedding is substantially of the composition described herein as "formulation 1".
10. An electric cable as claimed in Claim 8 in which the bedding is substantially of the composition described herein as "formulation 2".
11. An electric cable as claimed in any one of claims 1—9 including a longitudinal auxiliary wire conductor in continuous effective contact with the outer metal layer.
12. An electric cable as claimed in Claim 2 or Claim 3 or Claim 4 in which the outermost layer is of a plasticised PVC compound.
13. An electric cable as claimed in Claim 12 in which the PVC compound is a flame-retardant formulation.
14. An electric cable as claimed in Claim 13 in which the compound is claimed in any one claim of British Patent No. 1418027.
15. An electric cable as claimed in Claim 13 in which the PVC compound has calcium carbonate as filler and antimony trioxide as flame-retardant additive.
16. An electric cable as claimed in any one of claims 12—15 in which the PVC compound contains a basic filler with a specific area high enough to reduce the amount of hydrogen chloride gas and/or hydrochloric acid droplets in the smoke if the compound should be burnt.
17. An electric cable substantially as described herein as an Example of the invention.
- M. J. POOLE,
Chartered Patent Agents,
Agent for the Applicants,
38 Wood Lane,
London W12 7DX.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1981.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.



* C L M S *

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

1. The first of the two main parts of the report is a general survey of the situation in the country. This part is divided into two sections: the first deals with the political situation, and the second with the economic situation.

2. The second part of the report is a detailed analysis of the political situation. This part is divided into three sections: the first deals with the role of the government, the second with the role of the opposition, and the third with the role of the people.

3. The third part of the report is a detailed analysis of the economic situation. This part is divided into three sections: the first deals with the role of the government, the second with the role of the private sector, and the third with the role of the people.

4. The fourth part of the report is a conclusion. This part summarizes the main findings of the report and offers some suggestions for the future.

5. The fifth part of the report is an appendix. This part contains a list of references and a list of abbreviations.

[illegible][illegible]

THE PATENT OFFICE
- 8 JUN 1981
RECEIVED BY HAND