



(51) International Patent Classification:

H01B 13/14 (2006.01) *B29C 47/00* (2006.01)

(21) International Application Number:

PCT/IB2017/053246

(22) International Filing Date:

01 June 2017 (01.06.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/349,677 14 June 2016 (14.06.2016) US

(71) Applicant: **SABIC GLOBAL TECHNOLOGIES B.V.**
[NL/NL]; Plasticslaan 1, 4612 PX Bergen op Zoom (NL).

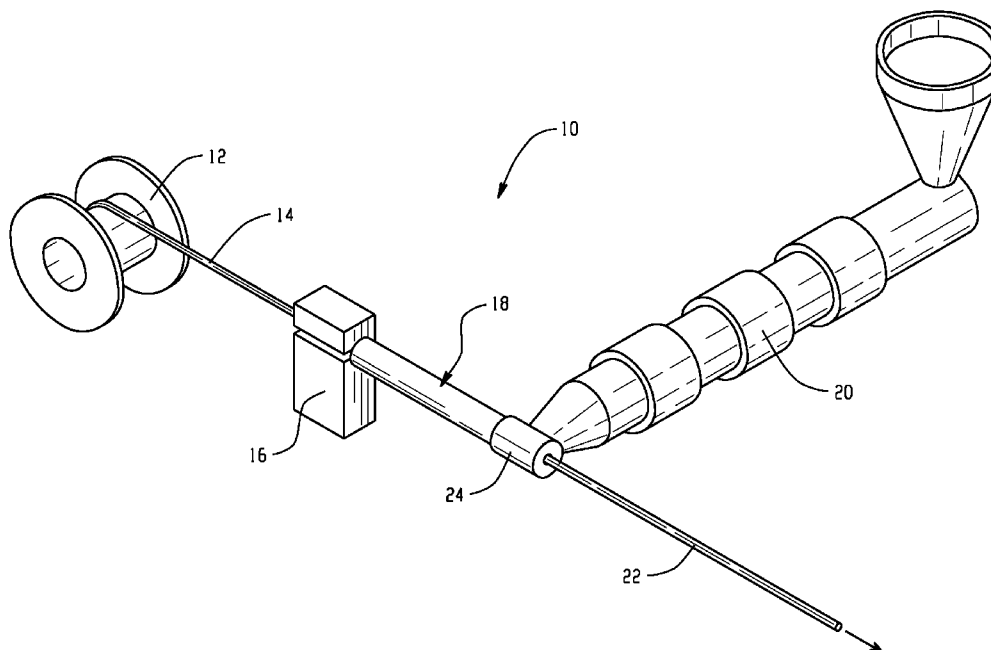
(72) Inventors: **YAMAMOTO, Takamune**; 2-2, Kinugaoka,
Moka, Tochigi 321-4392 (JP). **NAKASHIMA, Kouichi**;
2-2, Kinugaoka, Moka, Tochigi 321-4392 (JP).

(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR,
KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR,
TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

(54) Title: SYSTEMS AND METHODS FOR HIGH HEAT METAL WIRE COATING, AND COATED WIRE FORMED THERE-
FROM



(57) Abstract: Systems and methods for generating a metal wire coated with a polymer composition, the method including heating a metal wire to a temperature greater than the glass transformation temperature of the polymer composition, after the metal wire is heated and before the metal wire reaches a point where the metal wire is coated with the polymer composition, exposing the metal wire to an inert gas, and coating the metal wire with the polymer composition to form a coated metal wire, wherein the metal wire is exposed to the inert gas during coating.



Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*

SYSTEMS AND METHODS FOR HIGH HEAT METAL WIRE COATING, AND COATED WIRE FORMED THEREFROM

BACKGROUND

[0001] Electrically conductive metal wire has long been coated with insulative polymer. The conductive metal wire is conventionally made by first producing the bare wire and shaping it into the desired cross-section, and later, typically in a separate operation, the bare wire is coated with a polymeric material. For example, insulated conductive wires are commonly produced by passing the conductive wire through an extruder wherein a polymer composition, such as polyvinyl chloride, is applied around the conductive wire.

[0002] However, many problems exist when it comes to coating the conductive metal wire with a high temperature polymeric material because the process requires increasing the temperature greater than 150 °C during extrusion. Such high temperatures cause charring and deformation within the conductive metal wire, especially that of copper. As such, a need exists for a system and method for coating conductive metal wires with high performing high temperature polymeric material.

BRIEF DESCRIPTION OF THE DRAWING

[0003] Refer now to the figure, which is an exemplary embodiment.

[0004] FIG. 1 is a schematic of the system and method described herein.

DETAILED DESCRIPTION

[0005] Disclosed herein are systems and methods for continually coating conductive metal wires with high performance high temperature polymeric materials.

[0006] Electrical wire has been used in a wide variety of applications. In many applications the conductive metal wire is surrounded by an electrically insulating thermoplastic covering. Thermoplastic polyesters, crosslinked polyethylene, and halogenated resins such as fluoropolymers and polyvinyl chloride have long filled the needs in this challenging environment for heat resistance, chemical resistance, flame retardancy, and flexibility in the high temperature insulation. Thermoplastic polyester insulation layers have outstanding resistance to gas and oil, are mechanically tough and resistant to copper catalyzed degradation but can fail prematurely due to hydrolysis. The insulation layers in thermoplastic

polyester insulated electrical wires have also been found to crack when exposed to hot salty water and have failed when subjected to humidity temperature cycling.

[0007] There is an increasing desire to reduce or eliminate the use of halogenated resins in insulating layers, with many countries beginning to mandate a decrease in the use of halogenated materials. However, as much of the wire coating extrusion equipment was created based upon the specifications of halogenated resins such as polyvinyl chloride, it is desirable that any replacement materials be capable of being handled in a manner similar to polyvinyl chloride.

[0008] Crosslinked polyethylene has largely been successful in providing high temperature insulation but this success may be difficult to sustain as the requirements for electrical wire evolve. The dramatic increase in wiring has motivated wire producers to reduce the thickness of the insulation layer. However, such reductions in insulation wall thicknesses pose difficulties when using crosslinked polyethylene. For crosslinked polyethylene the thinner insulation layer thicknesses result in shorter thermal life, when aged at oven temperatures between 150 °C to 180 °C, which limits their thermal rating. The deleterious effects created by these extremely thin wall requirements have been attributed to copper catalyzed degradation, which is widely recognized as a problem in the industry.

[0009] High temperature insulation systems for metal wires are required in many applications including transformers, motors, generators, solenoids, and relays. As used herein, “high temperature” is a temperature of greater than 125°C, particularly temperature of up to 200°C (e.g., 125°C to 200°C). Requirements for such products include resistance to insulating fluids (such as a mineral oil, a silicon oil, a vegetable oil, a synthetic oil, and mixtures comprising at least one of the foregoing), and the ability to withstand overload conditions. Not only is the wire coating required to provide dielectric insulation, but it also must provide protection against abrasion, mechanical stress, and corrosion.

[0010] There are many difficulties in coating a metal wire, particularly a wire including copper, with a high performance high temperature polymer, such as polyetherimide, while maintaining a high continuous use temperature, strength, stiffness, adhesion of the polymer to the metal conductive wire, as well as other mechanical, thermal, and environmental properties. Specifically, increasing the preheating temperature to more than 150°C often results in oxidation and burn out of the copper wire. These problems are generally not an issue for lower temperature resins such as polyvinyl chloride (PVC) and polyolefins which can be used to coat the wires at lower temperatures due to their lower glass

transition temperatures (T_g). For example, PVC has a T_g of about 83°C, while polyetherimide has a T_g of about 217°C.

[0011] The Applicants surprisingly discovered that the metal wire can be heated to a temperature of greater than 150 °C when the metal wire is exposed to an inert gas while coating the metal wire with a polymer composition. In an example, an inert gas environment can be maintained during the preheating and extrusion of the polymer composition onto the metal wire. An inert gas environment can be continuously maintained around the wire during the wire forming and coating process. Not to be limited to theory, it is believed that because the metal wire can be heated to a temperature of greater than 150 °C, the metal wire can be coated with high performance, high temperature polymers without the copper wire experiencing oxidation or burn out while being coated. As a result, the systems and methods disclosed herein provide metal wires coated with high temperature polymers that exhibit robust electrical insulation, long term aging stability, environmental resistance, and optimal mechanical properties. For example, coated wires disclosed herein passed ISO6722-1:2011 class C requirement (temperature and humidity cycling test), when the wire was preheated to greater than or equal to 140°C (e.g., to greater than or equal to 150°C), while the wire coated with the same material failed this test when not preheated.

[0012] The metal wire can be any suitable conductive metal wire. The metal wire can include copper, aluminum, alloys of various metals, or combinations comprising at least one of the foregoing. For example, the wire can comprise copper. The metal wire may include a pre-coating material such as an adhesive overcoat. The metal wire can include two or more metal wires, with each metal wire including the same or different metal. The metal wire can comprise a single strand or a plurality of strands. In some embodiments, a plurality of strands may be bundled, twisted, or braided to form the metal wire. Additionally, the metal wire can have various shapes such as round or oblong. Examples of conductive metal wires include, but are not limited to, copper wire, aluminum wire, lead wire, and wires of alloys comprising one or more of the foregoing metals. The metal wire can also be coated with, for example, at least one of tin and silver. In some embodiments, the conductor metal wire can comprise one or more conductive wires, one or more metal foils, one or more conductive inks, or a combination comprising at least one of the foregoing. There is no particular limitation on the size of the metal wire. In some embodiments, the metal wire size is specified as American Wire Gauge (AWG) 28 to AWG 4/0, corresponding to a conductor diameter of 0.320 to

11.68 millimeter. In an example, the metal wire size can be as small as AWG 28 and as large as AWG4/0.

[0013] The polymer composition can be any material that, when coated on the wire, the wire meets ISO6722-1:2011. Some possible polymers include one or more of the following: polyetherimide (PEI), polycarbonate, polyamides, polyether ether ketone (PEEK), polyaryletherketone (PAEK), polyphenylene sulfide (PPS), among others, and alloys and copolymers thereof, such as polyetherimide sulfone, polyester-polycarbonate copolymers, polycarbonate siloxanes. For example, the polymer composition can include at least one of polyphenylene ether (PPE), polyetheretherketone (PEEK), and polyphenylene sulfide (PPS). The polymer can further comprise at least one of polyolefins (e.g., polyethylene (PE) and polypropylene (PP)), polystyrene (PS). For example, the polymer composition can comprise at least one of polyphenylene ether (PPE), polyetheretherketone (PEEK), and polyphenylene sulfide (PPS) along with at least one of polyolefins (e.g., polyethylene (PE) and polypropylene (PP)), polystyrene (PS). The polymer composition can comprise polyetherimide. For example, the polymer composition can comprise at least one of a polyetherimide alloys and a polyetherimide copolymer. The polymer composition can comprise polyphenylene ether. For example, the polymer composition can comprise at least one of a polyphenylene ether alloys and a polyphenylene ether copolymer, such as polyphenylene ether and a polyolefin.

[0014] The polymer composition can include a polymeric compatibilizer, a flame retardant, and optional other additives. Polymeric compatibilizers are resins and additives that improve the compatibility between a blend of polymers. Polymeric compatibilizers include block copolymers, polypropylene-polystyrene graft copolymers, and combinations thereof.

[0015] The coating thickness on the wires can be greater than or equal to 0.16 mm, such as 0.16 to 1.60 mm. For example, the coating thickness can be 0.16 to 0.20 in the case of ultra-thin wall for AWG 28 size conductor, or even 0.20 to 0.25 in case of thin wall for AWG 28 size conductor.

[0016] The method for generating a metal wire coated with a polymer composition can include heating a metal wire to a temperature greater than the glass transformation temperature of at least one polymer in the polymer composition. In an example, the metal wire can be heated to greater than 150 °C. The wire can be heated in any suitable manner and

device. For example, the metal wire can proceed through a preheater that heats the metal wire to the suitable temperature before being coated with the polymeric composition.

[0017] The metal wire can be heated in an inert environment and/or can be exposed to an inert environment before the metal wire is coated with the polymer composition. The inert environment comprises inert gas(es) that do not cause a chemical reaction with the wire or the polymer coating. The inert gas can be, for example, at least one of nitrogen, argon, helium, and carbon dioxide. The inert gas can be provided in an inert chamber that connects the preheater to the point of extrusion, such that the metal wire is not exposed to an oxygen containing environment (e.g., to air) between preheating and coating. Optionally, the inert environment can be maintained around the wire from during the preheating, throughout the coating process (e.g., through the extrusion of the polymer composition onto the wire). In such example, the inert chamber can encompass and enclose the preheater and at least the exit of the coating device (e.g., die of the extruder). For example, the inert gas can shroud the metal wire as it is fed into the extruder and as it exits the die. Desirably, the inert chamber has a pressure greater than the pressure outside the inert chamber to avoid displacement of the inert gas(es).

[0018] The melted polymer composition can be applied to the metal wire by an extruder to form a coated metal wire. The extruder can be equipped with a screw, crosshead, breaker plate, distributor, nipple, and die. The melted polymeric composition forms a coating around the circumference of the metal wire. The extrusion coating can employ a single taper die, a double taper die, other appropriate die, or combinations of dies to position the metal wire centrally to avoid die lip build up. Additional layers of the same or different polymer composition can be applied to the coated metal wire.

[0019] The method can include melt mixing (compounding) the polymer composition in a melt mixing device such as a compounding extruder or Banbury mixer. The polymer composition can be melt mixed at an extruder temperature greater than 150 °C, for example, 200°C to 420°C, or 220°C to 400°C, or 300°C to 400°C. Alternatively, the method can include a device other than an extruder, for example, a wire drawing or rolling machine may be used in the illustrated apparatus in the place of the extruder.

[0020] The melted polymer composition can be filtered through one or more filters having openings with diameters of 20 micrometers to 150 micrometers. For example, the openings may have diameters less than or equal to 130 micrometers, less than or equal to 110 micrometers, greater than or equal to 30 micrometers, or greater than or equal to 40

micrometers. Any suitable melt filtration system or device that can remove particulate impurities from the molten mixture may be used.

[0021] The coated metal wire can pass through additional zones such as cooling zone(s), further coating zone(s), collection zone(s), and combinations comprising at least one of the foregoing.

[0022] FIG. 1 is a schematic of the coating system 10 that includes a feed spool 12 that contains metal wire 14 wound onto a feed spool 12. The system can include a motor that directs the metal wire 14 through a preheater 16, an inert chamber 18, and a die 24 of an extruder 20 to form the coated metal wire 22. For example, the motor can rotate the roll with sufficient force (e.g., that can be controlled by tension) to move the metal wire 14 in a substantially straight and fixed path through the preheater 16, inert chamber 18, and die 24 of the extruder 20. When the metal wire 14 enters the die 24 the metal wire becomes coated with the polymeric material melted from the extruder 20 to form the coated metal wire 22. The inert chamber 18 can extend from and including the preheater 16 through the die 24 of the extruder 20.

EXAMPLES

[0023] Tensile elongation to break was determined according to JASO D618 (2013).

Example 1

[0024] The percent tensile elongation of two conventional copper wires coated with NORYL resins (WCV063 (PPO/PE) and WCV072 (PPO/PP) both comprising m-PPE) was determined using tensile tester AG-IS from Shimadzu Corporation. The wire was AWG14 metal wire with 0.25 mm insulation thickness. The copper wire in each 200 mm length sample was removed from the insulation resin without any mechanical damage. For each copper wire, the tensile elongation was compared between when the copper wire was preheated to 150°C in comparison to when no preheating was implemented. The results can be found in Table 1.

Table 1.		
	With Preheating to 150 °C	No Preheating
	Percent Tensile Elongation	
NORYL WCV063	140%	35%
NORYL WCV072	175%	40%

[0025] As demonstrated in Table 1, preheating the copper wire allows for a substantial increase in tensile elongation.

Example 2

[0026] In Example 2, 4 mm samples of copper conductor wires are placed onto a sample holder of a thermogravimetric analysis apparatus. A first copper wire sample was heated by 20 °C per minute in an air environment, and a second copper wire sample was heated by 20 °C per minute in an nitrogen environment. Each wire was maintained at 200 °C for 10 minutes and then cooled to room temperature.

[0027] When the temperature was increased to 200 °C in an air environment the copper wire surface color change due to surface oxidation. However, when the temperature was increased to 200 °C under a nitrogen environment, the copper conductor surface color did not change compared with the flesh (interior) of the copper wire.

Example 3

[0028] In Example 3, the temperature and humidity cycling test was determined based on ISO6722-1:2011 Class C and Class B temperature ratings.

[0029] The copper wire was coated with NORYL™ WCV063 resin. 600 mm length of sample was prepared, wound onto a mandrel, stored in an aging chamber, and aged. The aging temperature profile followed with listed temperature profile in ISO6722-1:2011 for 40 cycles. After aging cycle completion, the sample was unwound from the mandrel voltage tested in accordance with ISO6722-1:2011. The results can be found in Table 2.

Table 2		
	With Preheating to 150 °C	No Preheating
NORYL™ WCV063	Temperature and humidity cycling test result	
ISO6722-1:2011 Class C	Pass	Fail
ISO6722-1:2011 Class B	Pass	Pass

Example 4

[0030] Preheating at a lower temperature was also tested. The wire was copper wire, AWG22 costed with NORYL™ WCV072 resin with a 0.20 mm insulation thickness. Pre-heating to a temperature of 100°C resulted in a tensile elongation of 105%, while preheating to 150°C resulted in a tensile elongation of 169%.

[0031] As demonstrated in Table 2, preheating the copper wire allows for a substantial improvement in temperature and humidity cycling.

[0032] Set forth below are some embodiments of the methods and system disclosed herein.

[0033] Embodiment 1: A method for generating a metal wire coated with a polymer composition, the method comprising: heating a metal wire to a temperature greater than or equal to 150°C, wherein the temperature is greater than the glass transformation temperature of at least one polymer in the polymer composition; coating the metal wire with the polymer composition to form a coated metal wire; and cooling the coated metal wire; wherein, between the heating and the coating, the metal wire is maintained in an inert environment comprising inert gas.

[0034] Embodiment 2: The method of Embodiment 1, wherein heating the metal wire includes passing the metal wire through a pre-heater, wherein the pre-heater heats the metal wire from room temperature to the coating temperature.

[0035] Embodiment 3: The method of Embodiment 2, wherein from the pre-heater to a point the metal wire is coated with the polymer composition, directing the metal wire through an inert gas chamber wherein the metal wire is exposed to the inert gas, wherein the inert gas chamber is positioned between and including the preheater and the point where the metal wire is coated with the polymer composition.

[0036] Embodiment 4: The method of any of the preceding Embodiments, wherein the polymer composition comprises at least one of polyphenylene ether, polyetherimide, polyetheretherketone, polyphenylene sulfide, alloys thereof, and combinations thereof.

[0037] Embodiment 5: The method of any of the preceding Embodiments, wherein the metal wire includes copper.

[0038] Embodiment 6: The method of any of the preceding Embodiments, wherein the inert gas includes nitrogen.

[0039] Embodiment 7: The method of any of the preceding Embodiments, wherein the pre-heater heats the metal wire to a temperature of 200°C to 420°C, or 220°C to 400°C, or 300°C to 400°C.

[0040] Embodiment 8: The method of any of the preceding Embodiments, wherein the polymer composition comprises at least one of polyphenylene ether and polyetherimide; or comprises polyphenylene ether; or comprises polyetherimide.

[0041] Embodiment 9: The method of any of the preceding Embodiments, wherein the polymer composition further comprises polyolefin.

[0042] Embodiment 10: The method of any of the preceding Embodiments, wherein coating the metal wire with the polymer composition to form a coated metal wire includes directing the metal wire through an extruder wherein the polymer is applied to the metal wire.

[0043] Embodiment 11: A system for coating a metal wire, the system comprising: a spool of metal wire; a preheater; an extruder; an inert gas chamber positioned between the preheater and the extruder, wherein the inert chamber is configured to contain inert gas; and a motor for controlling the continuous movement of a metal wire through the preheater, the inert gas chamber, and the extruder.

[0044] Embodiment 12: The system of Embodiment 11, wherein the inert chamber extends from the preheater through a die of the extruder.

[0045] Embodiment 13: The system of any of Embodiments 11 - 12, wherein the inert gas chamber encloses the preheater and a die of the extruder.

[0046] In general, the invention may alternately comprise, consist of, or consist essentially of, any appropriate components herein disclosed. The invention may additionally, or alternatively, be formulated so as to be devoid, or substantially free, of any components, materials, ingredients, adjuvants or species used in the prior art compositions or that are otherwise not necessary to the achievement of the function and/or objectives of the present invention.

[0047] All ranges disclosed herein are inclusive of the endpoints, and the endpoints are independently combinable with each other (e.g., ranges of “up to 25 wt.%, or, more specifically, 5 wt.% to 20 wt.%”, is inclusive of the endpoints and all intermediate values of the ranges of “5 wt.% to 25 wt.%,” etc.). “Combination” is inclusive of blends, mixtures, alloys, reaction products, and the like. Furthermore, the terms “first,” “second,” and the like, herein do not denote any order, quantity, or importance, but rather are used to denote one element from another. The terms “a” and “an” and “the” herein do not denote a limitation of quantity, and are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The suffix “(s)” as used herein is intended to include both the singular and the plural of the term that it modifies, thereby including one or more of that term (e.g., the film(s) includes one or more films). Reference throughout the specification to “one embodiment”, “another embodiment”, “an embodiment”, and so forth, means that a particular element (e.g., feature, structure, and/or characteristic)

described in connection with the embodiment is included in at least one embodiment described herein, and may or may not be present in other embodiments. In addition, it is to be understood that the described elements may be combined in any suitable manner in the various embodiments.

[0048] While particular embodiments have been described, alternatives, modifications, variations, improvements, and substantial equivalents that are or may be presently unforeseen may arise to applicants or others skilled in the art. Accordingly, the appended claims as filed and as they may be amended are intended to embrace all such alternatives, modifications variations, improvements, and substantial equivalents.

[0049] I/we claim:

CLAIMS:

1. A method for generating a metal wire coated with a polymer composition, the method comprising:

heating a metal wire to a coating temperature greater than or equal to 150°C, wherein the coating temperature is greater than the glass transformation temperature of at least one polymer in the polymer composition;

coating the metal wire with the polymer composition to form a coated metal wire; and cooling the coated metal wire;

wherein, between the heating and the coating, the metal wire is maintained in an inert environment comprising inert gas.

2. The method of Claim 1, wherein heating the metal wire includes passing the metal wire through a pre-heater, wherein the pre-heater heats the metal wire from room temperature to the coating temperature.

3. The method of Claim 2, wherein from the pre-heater to a point the metal wire is coated with the polymer composition, directing the metal wire through an inert gas chamber wherein the metal wire is exposed to the inert gas, wherein the inert gas chamber is positioned between and including the preheater and the point where the metal wire is coated with the polymer composition.

4. The method of any of the preceding claims, wherein the polymer composition comprises at least one of polyphenylene ether, polyetherimide, polyetheretherketone, polyphenylene sulfide, alloys thereof, and combinations thereof.

5. The method of any of the preceding claims, wherein the metal wire includes copper.

6. The method of any of the preceding claims, wherein the inert gas includes nitrogen.

7. The method of any of the preceding claims, wherein the pre-heater heats the metal wire to a temperature of 200°C to 420°C, or 220°C to 400°C, or 300°C to 400°C.

8. The method of any of the preceding claims, wherein the polymer composition comprises at least one of polyphenylene ether and polyetherimide; or comprises polyphenylene ether; or comprises polyetherimide.

9. The method of any of the preceding claims, wherein the polymer composition further comprises polyolefin.

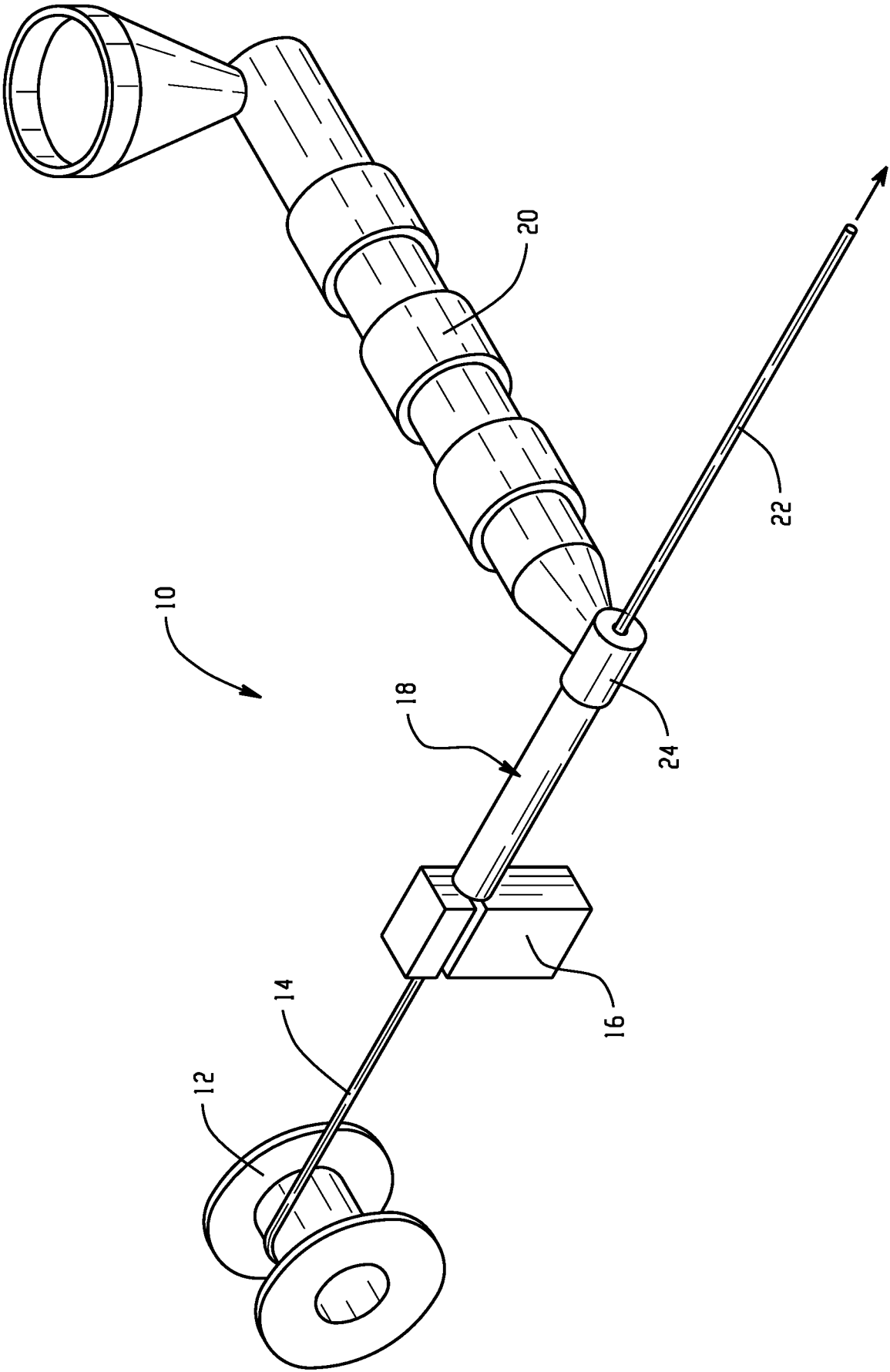
10. The method of any of the preceding claims, wherein the polymer composition further comprises polystyrene.

11. The method of any of the preceding claims, wherein coating the metal wire with the polymer composition to form a coated metal wire includes directing the metal wire through an extruder wherein the polymer is applied to the metal wire.

12. A system for coating a metal wire, the system comprising:
a spool of metal wire;
a preheater;
an extruder;
an inert gas chamber positioned between the preheater and the extruder,
wherein the inert chamber is configured to contain inert gas; and
a motor for controlling the continuous movement of a metal wire through the preheater, the inert gas chamber, and the extruder.

13. The system of Claim 11, wherein the inert chamber extends from the preheater through a die of the extruder.

14. The system of any of Claims 11-12, wherein the inert gas chamber encloses the preheater and a die of the extruder.



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/053246

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01B13/14 B29C47/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01B B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP S50 43483 A (YAZAKI CORP) 19 April 1975 (1975-04-19) figures 1,2 page 409, column 2 - page 410, column 2 -----	1-14
X	JP 2004 335217 A (YAZAKI CORP) 25 November 2004 (2004-11-25) paragraph [0011] - paragraph [0047] -----	1-14
A	JP S61 142611 A (FURUKAWA ELECTRIC CO LTD) 30 June 1986 (1986-06-30) pages 47-49 figures 1,2 -----	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent 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 when the document is taken alone

"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

Date of the actual completion of the international search

21 September 2017

Date of mailing of the international search report

05/10/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Poole, Robert

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2017/053246

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP S5043483 A	19-04-1975	JP S586251 B2 JP S5043483 A	03-02-1983 19-04-1975
JP 2004335217 A	25-11-2004	NONE	
JP S61142611 A	30-06-1986	JP H0217884 B2 JP S61142611 A	23-04-1990 30-06-1986