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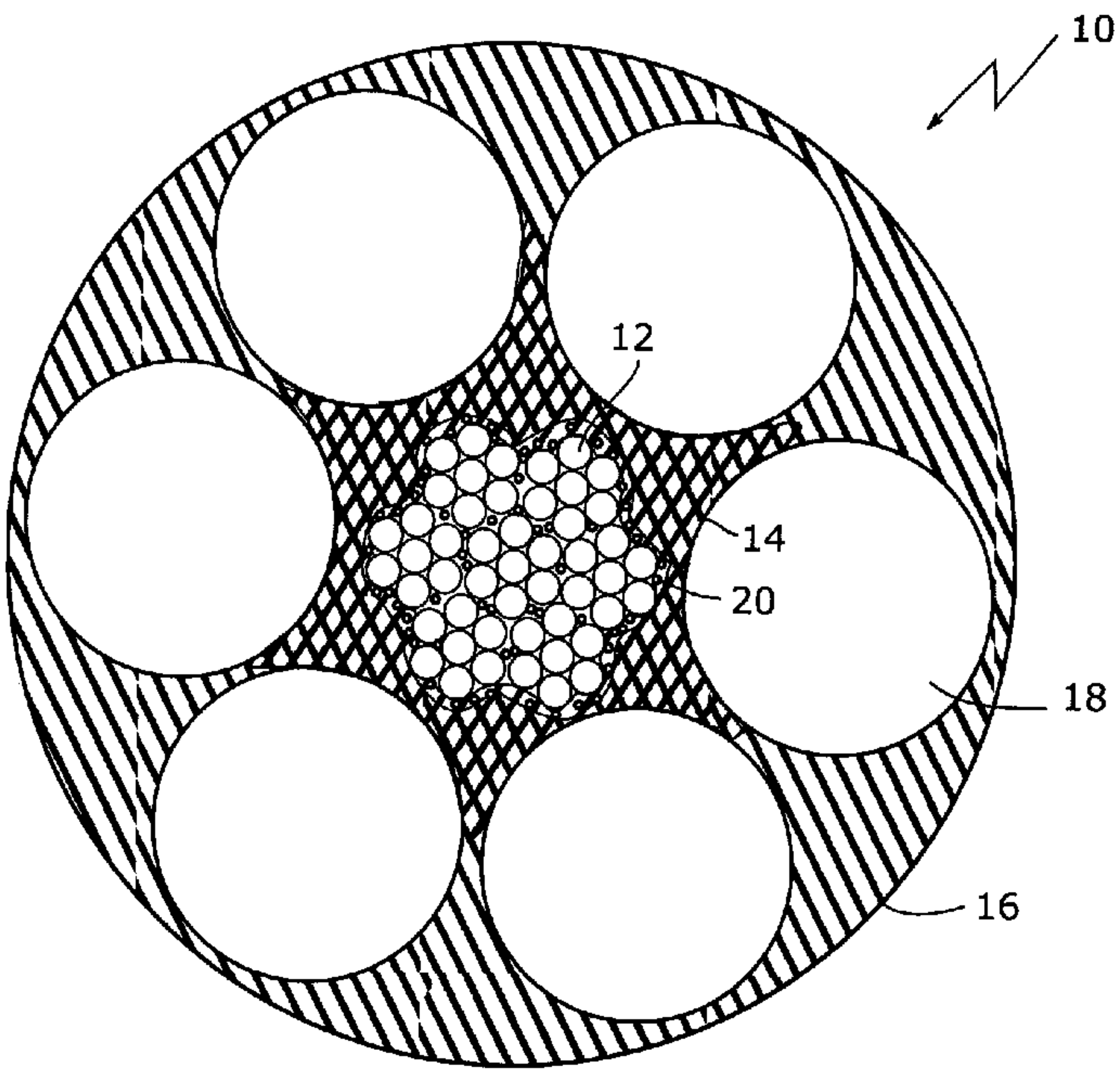


(57) Abrégé/Abstract:
A wire rope has a lubricated core, an inner jacket portion in contact with the core and outer strands wrapped around the inner jacket portion. An outer jacket portion surrounds the outer strands and contacts the inner jacket portion to form an integrated jacket.

ABSTRACT OF THE DISCLOSURE

A wire rope has a lubricated core, an inner jacket portion in contact with the core and outer strands wrapped around the inner jacket portion. An outer jacket portion surrounds the outer strands and contacts the inner jacket portion to form an integrated jacket.

JACKETED WIRE ROPE

TECHNICAL FIELD

[0001] Jacketed wire rope and method of manufacture.

BACKGROUND

[0002] Attempts have been made to impregnate wire rope with plastic materials in order to decrease wear and fatigue of the rope and increase its life. For example, Canadian Patent No. 582,779 describes vacuum impregnation of wire ropes with an elastomeric plastic material which is subsequently caused to undergo setting or gelation within the rope. Canadian Patent No. 716,845 describes a standard wire rope wherein synthetic plastic material is worked into the natural gaps in such a manner that it engages laterally in the gaps between the wires of the outer strands.

[0003] Canadian Patent No. 1,007,526 describes a method of impregnating lubricated wire rope with a thermoplastic material wherein the rope is first formed while coating the strands with a heavy viscous lubricant, then the lubricated rope is preheated and the outer strands of the wire rope are held spaced apart from one another. Finally, the rope is impregnated with a plastic composition so as to entrap the lubricant in the core and the strands. US 4,667,462 notes disadvantages of Canadian Patent No. 1,007,526, including the risk of peeling of plastic material from poor adherence of the plastic material to the wire.

[0004] US Patent No. 3,705,489 discloses a plastic jacket around the core of wire ropes in an attempt to retain lubrication or prevent the escape of lubrication and to help reduce strand to strand contract by enhancing uniform strand spacing. A plastic impregnated rope process was disclosed in US Patent No. 5,386,683, involving encapsulating a core with a plastic jacket, and applying plastic fillings in gaps between the outer strands to create uniform gaps between strands while the rope is in operation.

SUMMARY

[0005] In an embodiment, there is provided wire rope, comprising a lubricated core, an inner jacket portion contacting the core; outer strands wrapped around the inner jacket portion; and an outer jacket portion surrounding the outer strands and contacting the pores of the inner jacket portion to form an integrated jacket.

[0006] In an embodiment, there is provided a method of constructing a wire rope from a core and outer strands, the core being lubricated, comprising applying an inner jacket portion by cold application to the core; and closing the outer strands over the inner jacket portion while applying a molten material to the outer strands at a temperature and pressure sufficient to cause the molten material to contact the inner jacket portion to form an integrated jacket that includes the inner jacket portion, the inner jacket portion having an equal or higher melting point than the molten material.

[0007] In an embodiment, there is provided a method of constructing a wire rope from a core and outer strands, the core being lubricated, comprising: applying an inner jacket portion by cold application to the core, the inner jacket portion being permeable and having pores or voids; and closing the outer strands over the inner jacket portion while applying a molten material to the outer strands at a temperature and pressure sufficient to cause the molten material to migrate into pores or voids of the inner jacket portion such that the molten material cools as the molten material passes through the pores or voids of the inner jacket portion to form an integrated jacket that includes the inner jacket portion, the inner jacket portion having an equal or higher melting point than the molten material.

[0008] In various embodiments, there may be included any one or more of the following features: the inner jacket portion is formed of a material with a first melting point, the outer jacket portion is formed of a material with a second melting point; and the melting point of the material of the inner jacket portion is higher than the melting point of the material of the outer jacket portion; the inner jacket portion is porous, and the outer jacket portion contacts the pores or voids of the inner jacket portion; the inner jacket portion forms a matrix; the inner jacket portion is formed by crossing fibrous material; the inner jacket portion is formed by grids of material laid on top of each other; the inner jacket portion is formed from a material having undulations or waves; the inner jacket portion is permeable, and the outer jacket portion permeates at least partly into the inner jacket portion; the molten material of the outer jacket portion fills gaps between outer strands; the inner jacket portion at least partly fills gaps between outer strands.the molten material fills gaps between outer strands; the outer jacket portion surrounds the outer strands; the inner jacket portion is compressible; the inner jacket portion is made of plastic; the inner jacket portion is made of metal; the inner jacket portion is tubular; the core is an independent wire rope core; the outer strands, the core or wires of either or both are galvanized; the inner jacket portion has a porosity between 5 PPI and 50 PPI; the pores of the inner jacket portion have an open cell configuration; the inner jacket portion has an impermeable floor which traps lubrication within the core; the inner jacket portion has a floor having an open celled configuration; the outer jacket portion is made of plastic; the plastic of the outer jacket portion is polypropylene, polyethylene, polystyrene, nylon or tetrafluorethylene.

[0009] In various embodiments, there may be included any one or more of the following steps: further comprising compressing the inner jacket portion with the outer; closing the outer strands is simultaneous with the step of applying the molten material to the inner jacket portion; galvanizing wires of the outer strands; the inner jacket is tubular prior to application to the core.

[0010] These and other aspects of the device and method are set out in the claims.

BRIEF DESCRIPTION OF THE FIGURES

[0011] Embodiments will now be described with reference to the figures, in which like reference characters denote like elements, by way of example, and in which:

[0012] Fig. 1 is a cross-section view of an embodiment of a wire rope.

[0013] Fig. 2 is a cross-section view of an embodiment of a wire rope before the outer jacket portion and outer strands have been applied.

[0014] Fig. 3 is a cross-section view of a further embodiment of a wire rope.

[0015] Fig. 4 is a cross-section view of part of an integrated jacket from an embodiment of a wire rope.

[0016] Figs. 5 and 6 area flow charts of the steps of the independent method claims.

[0017] Fig. 7 shows examples of forms of the inner jacket portion.

DETAILED DESCRIPTION

[0018] Immaterial modifications may be made to the embodiments described here without departing from what is covered by the claims. In the claims, the word “comprising” is used in its inclusive sense and does not exclude other elements being present. The indefinite articles “a” and “an” before a claim feature do not exclude more than one of the feature being present. Each one of the individual features described here may be used in one or more embodiments and is not, by virtue only of being described here, to be construed as essential to all embodiments as defined by the claims.

[0019] As shown in Figs. 1 and 2, an embodiment of a wire rope 10 has a lubricated core 12, which may be for example an independent wire rope core, a strand core, a fiber core or a plastic core. An inner jacket portion 14 contacts the core 12. A plurality of outer strands 18 is wrapped around the inner jacket portion 14. A plastic outer jacket portion 16 surrounds the outer strands 18 and contacts the inner jacket portion 14. The inner jacket portion 14 may have a higher melting point than the outer jacket portion 16. In some embodiments, the inner jacket portion 14 may have the same melting point as or a lower melting point than the outer jacket portion 16.

[0020] In an embodiment, the inner jacket portion is porous. The outer jacket portion 16 contacts the pores 19 of the inner jacket portion 14, as shown in Fig. 4. By contacting is meant that the outer jacket portion material enters into the pores 19 of the inner jacket portion material to help form a bond between the inner jacket portion 14 and the outer jacket portion 16. The material forming the plastic outer jacket portion 16 may extend a varying degree into the inner jacket portion 14, from filling some of the pores of the inner jacket portion 14 to filling all of the pores 19 of the inner jacket portion 14. In some embodiments, the plastic of the outer jacket portion 16 may extend inwardly through the inner jacket portion 14 into the core 12. The combined inner jacket portion 14 and outer jacket portion 16 together form a single integrated jacket for the wire rope. Fig. 4 shows a cross-section of part of an integrated jacket in which the outer jacket portion 16 has filled the pores 19 of the inner jacket portion 14.

[0021] The inner jacket portion 14 may be compressible. The outer strands 18 may be compressed against the inner jacket portion 14. Fig. 2 shows the inner jacket portion 14 surrounding the core 12 before compression. The compression of the outer strands 18 may result in the inner jacket portion 14 being compressed or crushed into a new shape and forced into voids and gaps within the wire rope. The voids and gaps may for example be gaps between each of the outer strands 18, between the outer strands 18 and the core 12, and between strands and wires of the core 12. The compression of the inner jacket portion 14 into gaps of the wire rope may prevent strand to strand or core to strand contact.

[0022] The outer jacket portion 16 may be impregnated or injected on to the surface of and into the inner jacket portion 14 surrounding the core 12 and into the outer strands 18 as a molten material that passes through the outer strands 18 to the inner jacket portion 14. The molten material may be applied to the surface of the inner jacket portion 14 surrounding the core 12 and outer strands 18 simultaneously with closing the outer strands 18 around the inner jacket portion 14. The outer strands 18 may be wrapped around the outer jacket portion 16 and compressed against the inner jacket portion 14, forcing the material of outer jacket portion 16 to spread in between the outer strands 18 and into the inner jacket portion 14.

[0023] The inner jacket portion 14 may for example be made of metal or plastic. A plastic inner jacket portion 14 may be made from any suitable material including polyamide plastics, plastic nylons, syscal, jute, neophrane, aramid fibers, synthetic aromatic polyamide polymer, polymer fibers, or cotton jute. The inner jacket portion 14 may for example be reticulated filter foam. A metal inner jacket portion 14 may for example be made of tin, aluminum, copper, steel, or iron, and may be stainless steel or contain galvanized wires. A plastic inner jacket portion 14 may for example be made of polyethylene, polypropylene polymide, polyurethane, polytetrafluroethylene, polyvinylindene flouride, ethyl vinyl acetate, polycarbonate (and alloys), nylon 6, or thermosplastic polyersulfone. The material of the inner jacket portion 14 may also be enhanced metal, a hybrid metal material, glass or metal sponge. The inner jacket portion 14 may be permeable, such that molten plastic and wire rope lubrication may move through the inner jacket portion 14 when the inner jacket portion 14 is closed over the core 12 of the wire rope. The inner jacket portion may be porous, such that the inner jacket portion include pores, or may form a matrix, be formed by crossing fibrous material or layering grids of material, each of which may have voids such as holes or openings which may allow fluid to permeate through the inner jacket portion 14. The holes of the matrix, crossed fibrous material or layered grids may be interconnected such that liquid may pass through holes from one side of the matrix, crossed fibrous material or layered grids to the other side. The pores or holes may be occupied by molten or solidified plastic of the outer jacket portion 16 or core lubricant or both. The outer jacket portion 16 may permeate partly or fully into the inner jacket portion 14. By matrix is meant that material is interlaced to form a structure having spaces between the interlaced materials. By crossed fibrous material is meant that lengths of fibrous material are crossed at angles with each other to form a network, such as for example a grid.

[0024] In some embodiments, the inner jacket portion 14 is formed of a material having undulations or waves. The outer jacket portion 16 contacts the “hills” and “valleys” of the undulations or waves to anchor the outer jacket portion 16 to inner jacket portion 14. In some embodiments, the material having undulations or waves is permeable, for example by being made from a permeable material. In other embodiments, the material having undulations or waves is non-permeable to prevent movement of fluid into or out of the core.

[0025] The inner jacket portion 14 may provide a protective layer between the lubrication of the core 12 and the heat required to impregnate the outer strands 18 with the outer jacket portion 16. The inner jacket portion 14 material may have a melting temperature high enough to prevent displacement or removal of the lubricant. The inner and outer jacket portion together form a unified jacket which may provide cushioning for the wire rope to absorb friction and vibration. This unified jacket acts as a separator between the strands to prevent strand contact and abrasion. The unification of the inner jacket portion 14 and the outer jacket portion 16 to form an integrated jacket anchors the outer jacket portion 16 within the wire rope 10.

[0026] The core 12 is filled with lubricant 20 prior to application of the inner jacket portion 14 around the core 12 and prior to the application of the outer jacket portion and closing the outer strands 18 around the core. The lubricant 20 may be for example hot applied (petroleum based) or cold applied (asphalt based) or may be a synthetic lubricant such as silicones, diesters, phosphate esters, polygloycols, flourocarbons, and polyphenyl ethers. In some embodiments, when the outer jacket portion 16 is applied, the outer jacket portion material may flow through pores or holes of the inner jacket portion and in and around the outer strands 18 inwardly into the inner jacket portion 14 through the pores until it reaches the outer surface of the core 12. The lubricant may begin softening, melting or be forced upwards into the outer jacket portion material.

[0027] The inner jacket portion 14 may have an impermeable floor, membrane or base 22 adjacent the core 12 which traps lubrication within the core 12, or impedes movement of lubrication from the core 12. In some embodiments, the jacket floor 22 is impermeable, as shown in Fig. 3, and may for example be closed celled to prevent lubrication migration. In other embodiments, the floor 22 may be open celled to permit limited lubrication movement into the pores of the inner jacket portion. In some embodiments, the floor is slightly permeable, for example by having small connected pores or holes to permit small amounts of lubricant 20 to pass into the inner jacket portion. In some embodiments, the floor is porous and has a different porosity from that of the inner jacket portion 14. Lubrication of the core 12 helps to extend the working life of the wire rope 10. The unified jacket may provide a barrier to prevent as much as practically possible the lubrication from escaping the wire rope 10. The floor 22 may be made of one or more materials, such as two different plastics, of differing porosity and/or permeability, or the same material with portions having different porosity and/or permeability. The floor 22 may thus have an inner portion and outer portion. One or both of the inner portion and the outer portion of the floor 22 may be impermeable.

[0028] In some embodiments, the materials of the inner jacket portion 14 may be absorbent only by means of being porous, such that the many pores receive liquid in them, or by forming matrix, lattice or framework having holes which may fill with liquid. The pores (or holes or openings) 19 of the inner jacket portion 14 may be of different shapes and sizes, and may be randomly placed or organized for example linearly or in layers. For example, the pores 19 may be circular, square, or rectangular. The inner jacket portion 14 may have between 50 pores per inch (PPI) and 5 PPI. Multiple instances of inner jacket portion 14 may be applied to wire rope 10. The pores may have an open cell configuration. The inner jacket portion 14 for example may have a honeycomb shape, or may be sponge-like, netted, webbed, meshed, grated, or corrugated. The inner jacket portion 14 may be formed of a network of connecting threads, walls or netting, such as in a scrubbing sponge or filter. The inner jacket portion may be a combination of any of the above forms, and may also be a combination of the above forms and any one or more of a matrix, crossed fibrous material or layered grids. Fig. 7 shows examples of some possible forms of the inner jacket portion 14. The inner jacket portion 14 may be installed as a single layer or may have multiple layers having different permeability to provide different levels of penetration of the lubricant and plastic outer jacket portion 16. An inner jacket portion 14 may be applied inside the core 12, for example to the core nucleus. Various inner jacket portions 14 be integrated into the core and may extend out of the core to surround the core. Each inner jacket portion 14 may be impregnated with outer jacket portion 16.

[0029] The outer jacket portion 16 may be made of plastic. The outer jacket portion 16 may be impregnated into the pores of inner jacket portion 14 and on to the surface of inner jacket portion 14. The outer jacket portion 16 may be impregnated on the strands by extrusion of the hot plastic. The outer jacket portion may extend beyond the periphery of the closed outer strands 18 by a thickness of between 0.025" – 0.060". The outer jacket portion may be concentric with the diameter of steel wire rope, or may be eccentric within a range of 0.025".

[0030] The outer jacket portion 16 may have a lower melting point than the material of the inner jacket portion 14 and is applied in a melted state to the inner jacket portion 14. The outer strands 18 and the inner jacket portion 14 may be filled by molten material that is used to form the outer jacket portion 16, which may prevent metal to metal contact between the outer strands 18 and adjacent outer strands 18, as well as between the outer strands 18 and the core 12. The gaps between the outer strands 18 may be filled by molten material used to form the outer jacket portion 16 during the closing of the outer strands 18 on to the core 12. The amount of outer jacket portion material required to fill voids will depend on the sizes of the outer strands 18 and core 12. The impregnation of the inner jacket portion 14 with the outer jacket portion 16 may be performed under pressure by specialized extrusion equipment. For example, where the outer jacket portion 16 is made of polypropylene, pressure may be applied in the range of 10 – 30 MPa, and have a plastic melting temperature of ~200°C. The pressure at which the outer jacket portion 16 is extruded is adjusted based on the desired amount of infiltration of the outer jacket portion 16 into the inner jacket portion 14. The pressure may depend on the lay length of the wire rope 10, the thickness of the inner jacket portion 14, the viscosity of the molten plastic, and the type of regulator that performs the extrusion. The temperature to which the outer jacket portion 16 is heated for extrusion will be greater than the melting temperature of the material of the outer jacket portion 16

[0031] The molten material used to form the outer jacket portion 16 passes through the network of pores to adhere and anchor to the inner jacket portion 14. The combination of the inner jacket portion 14 and outer jacket portion 16 forms a seal against lubricant leaving the core 12. Effectively, the application of the molten material to the outer strands 18 and the inner jacket portion 14, followed by the cooling of the molten material to solidify between the outer strands 18 and in pores of the inner jacket portion 14, creates a unified jacket around the core 12.

[0032] The outer strands 18 may be galvanized or contain galvanized wires. Galvanizing may promote plastic adherence and resistance to rust. Individual wires forming the outer strands 18 may also be galvanized. In embodiments where the core 12 includes core strands, the core strands or individual wires in the core strands may be galvanized.

[0033] The molten material may be of a temperature that causes some melting of the inner jacket portion 14, provided that application of the molten material does not burn or melt off all lubricant 20.

[0034] In Fig. 5, a flow chart of a method of constructing a wire rope 10 from a lubricated core 12 and plural outer strands 18 is shown. The method includes the following steps: applying an inner jacket portion 14 by cold application to the core 12; and closing the outer strands over the inner jacket portion 14 while applying a molten material to the outer strands 18 at a temperature and pressure sufficient to cause the molten material to contact the inner jacket portion 14 to form an integrated jacket that includes the inner jacket portion 14, the inner jacket portion 14 having an equal or higher melting point than the molten material.

[0035] In Fig. 6, a flow chart of a method of constructing a wire rope 10 from a lubricated core 12 and plural outer strands 18 is shown. The method includes the following steps: applying an inner jacket portion 14 by cold application to the core 12, the inner jacket portion being permeable and having pores or voids; and closing the outer strands 18 over the inner jacket portion 14 while applying a molten material to the outer strands 18 at a temperature and pressure sufficient to cause the molten material to migrate into pores or voids of the inner jacket portion 14 such that the molten material cools as the molten material passes through the pores or voids of the inner jacket portion 14 to form an integrated jacket that includes the inner jacket portion 14, the inner jacket portion 14 having a higher melting point than the outer jacket portion 16. The outer jacket portion 16 may be impregnated into the inner jacket portion 14 under pressure by specialized extrusion equipment. Application of the molten material may be directed first to the inner jacket portion 14 prior to closing of the outer strands, and may also be applied during the closing of the outer strands.

[0036] The voids in the inner jacket portion may be the result of the inner jacket portion being in the form of a matrix, crossing fibrous material or layering grids of material, each of which may have voids such as holes or openings which may allow fluid to permeate through the inner jacket portion 14.

[0037] Cold application means sufficiently cool that the application of the inner jacket portion does not cause lubrication loss in or on the core, and may for example comprise application of the inner jacket without a separate heating step, and may comprise application of the inner jacket at an ambient temperature below 10°C, 20°C, 30°C or 40°C.

[0038] The inner jacket portion 14 may be compressed by the outer strands 18 during closing of the outer strands 18 around the inner jacket portion 14 and core 12. Compressing the inner jacket portion 14 may deform the inner jacket portion 14 to force the inner jacket portion 14 into the gaps between adjacent outer strands 18 or the core 12. In some embodiments, plastic trapped within the pores of the inner jacket portion 14 is forced out during compression while the outer strands are closing around the inner jacket portion, and is forced into gaps and voids between strands and wires of the wire rope 10. Filling of gaps helps to reduce metal strand to strand contact and to increase anchoring of the integrated jacket.

[0039] The molten material may have an equal or lower melting temperature than the material of the inner jacket portion 14. In some embodiments, the inner jacket portion 14 has a lower melting temperature than that of the molten material being impregnated, which may reduce the amount of integration of the inner jacket portion 14 and outer jacket portion 16. The molten material may be impregnated into the inner jacket portion 14 and the outer strands 18. The molten material may thus enter the pores of the inner jacket portion 14, and by filling a portion of the pores form a denser inner jacket portion 14. The pores of the porous material of the inner jacket portion 14 adhere to the molten material and anchor the inner jacket portion 14 to the molten material. The molten material may thus combine with the inner jacket portion material to form a combined network of the inner jacket portion 14 with the molten material. This application of the molten material to the inner jacket portion is believed to reduce lubricant removal which may occur in typical plastic impregnation of wire ropes. The molten material cools to form outer jacket portion 16.

[0040] The densification of the inner jacket portion 14 using the molten material may increase the strength and interconnectedness of the inner jacket portion 14 to bind the wire rope together. As the molten material cools to form outer jacket portion 16, the pores entrap the plastic and are filled with outer jacket portion material which has moved around and in between the outer strands 18 and the core 12. The inner jacket portion 14 and outer jacket portion together form a unified, new jacket. The inner jacket portion 14 may prevent the outer jacket portion from sloughing off between valleys of the outer strands 18 by promoting adherence of the outer jacket portion material to the inner jacket portion 14. The impregnation of the outer strands 18 with the outer jacket portion may result in the outer jacket portion surrounding the wire rope.

[0041] Lubrication may be contained in and around the core 12 by the inner jacket portion 14. The lubrication may improve the wear and fatigue resistance of the wire rope.

[0042] The outer strands 18, the individual wires of the outer strands 18, or the core strands may be galvanized. The galvanizing of the outer strands 18 may enhance adherence of the outer strands 18 with the material of the outer jacket portion. The zinc coating may help hold the outer jacket portion in place and reduce the effects of moisture intrusion.

[0043] Closing the outer strands 18 may be simultaneous withfilling the outer strands 18 with molten material of the outer jacket portion. In some embodiments, the molten material is applied directly to the inner jacket portion prior to strand closure and/or during strand closure. The outer strands may be spaced apart during the application of the molten material, for example by using a strand gap controller, such as is known in the art. In other embodiments, closing the outer strands 18 may be simultaneous with applying the molten material to the inner jacket portion 14. The molten material of the outer jacket portion 16 may be injected or impregnated into the outer strands 18. Filling or partially filling the inner jacket portion 14 with the outer jacket portion 16 may be through impregnation, and the impregnation may take place under pressure. The impregnation of the outer jacket portion on the outer strands 18 may occur with the outer jacket portion in a liquid molten state. The temperature of the molten outer jacket portion is higher than the melting point of the outer jacket portion material and lower than the melting temperature of the inner jacket portion 14. The molten outer jacket portion material may be forced into the open pores of the inner jacket portion 14 during impregnation to fill at least some of the pores of the inner jacket portion 14. Compression of the outer strands 18 towards the core 12 may also contribute to filling of the pores and the gaps between and within the core 12 and the outer strands 18. The thickness of the inner jacket portion 14 is dependent on the wire and strand diameters and the oversize tolerances of the wire rope 10.

[0044] The molten material which forms the outer jacket portion 16 may be made of plastic, such as for example polypropylene, polyurethane, polyethylene, polystyrene, nylon or tetrafluorethylene, which have the following melting points:

Material	Melting point (Celsius)	Melting point (Fahrenheit)
POLYPROPYLENE (isotactic)	171	340
POLYPROPYLENE (commercial isotactic)	160-68	320-331
POLYETHYLENE (LD)	198	325
POLYETHYLENE (HD)	240	400
POLYSTYRENE	234	390
NYLON	260 – 273	500 - 525
TETRAFLUORETHYLENE	224	142

[0045] For example, commercial isotactic polypropylene may be used to form the outer jacket portion 16, which melts at between 160-168°C. The polypropylene may then be extruded at a temperature in the range of 190°C to 210°C, such as for example 200°C, which may vary by several degrees depending upon the physical makeup and melting point of the inner jacket portion 14.

[0046] Prior to application of the inner jacket portion 14 to the core 12, the inner jacket portion 14 may have a variety of shapes, including for example tubular or flat (blanketed or Kevlar™ type), and may be for example a tube, sheet, roll or sleeve. Strips may be applied along the entire length of the wire rope. The inner jacket portion 14 may be wrapped around the core 12. The inner jacket portion 14 may be a sock. A tubular jacket may have a split to allow easy opening of the jacket so that it may fitted or snapped around the core 12. Multiple tubular jackets may be used to cover the core 12 of the entire rope.

[0047] The core, which may be for example IWRC, hybrid or enhanced core, and the core strands may be swaged, by a hammering method, such as is described in US patent no. 9,428,858. The core 12 may be manufactured by a method that requires die or roller preforming or compacting of the individual wires that make up each of the strands. For example, a wire rope may have a diameter of 2 ¾" with an IWRC and 8 outer strands 18 laid about the core 12, with the core 12 being 1.58" and each of the outer strands 18 approximately 0.56" each. In this example, the impregnated inner jacket portion 14 may have radial thickness of approximately 0.025" to 0.60".

[0048] The inner jacket portion 14 may surround the core 12 to a thickness of anywhere from 0.1 cm or less to 30 cm or more depending on the finished diameter of the wire rope. The inner jacket portion may also be formed of more than one layer of material, such as grids overlying each other. The diameter of the core may be reduced depending on the size of the inner jacket portion in order to obtain a desired finished rope diameter. The core 12 can be manufactured using a wide range of constructions, such as for example 6x31 or 9x40. The depth and volume of the inner jacket portion 14 is determined as per individual requirements. The dimensions of the individual strands, core, and finished wire rope may be the same as the corresponding dimensions of a standard rope without a jacket surrounding the core.

[0049] In a wire rope that has an inner jacket portion 14, the core 12 may be reduced in size compared to the core of a wire rope of the same size which does not have an inner jacket portion 14. The core 12 may be smaller than a normal core rope having the same outer dimensions in order to provide space for a thicker plastic jacket than would otherwise be permitted by the rope structure. For example, the diameter of the core 12 of the wire rope, whether the core 12 is IWRC or a wire strand core, can be reduced as much as 15 to 17 percent from the normal size in a rope of comparable diameter, without significantly reducing the overall strength if the wire rope. An intergrated inner jacket portion 14 and outer jacket portion having a thickness sufficient to increase the core size from 20 to 25 percent may be placed over the lubricated core. The outer strands 18 may seat into the intermingled inner and outer jacket portion, for example through compression of the outer strands. Spacing of the outer strands may be required during impregnation of the material of the outer jacket portion to allow the material of the outer jacket portion to infiltrate the pores of the inner jacket portion. The spacing may occur during closing of the outer strands over the inner jacket portion.

[0050] Wherever a “core” is referred to herein, the core may include any typical core such as a wire strand core or IWRC, and may also include a core and one or more layers of strands. The interconnected inner and outer jacket portion may be applied at multiple stages between various layers of a wire rope.

[0051] In an embodiment, the wire rope is shovel mining rope, which may for example be 8x36 (electric) shovel mining rope.

[0052] Prior to application of the outer jacket portion 16, the inner jacket portion 14 is sufficiently flexible to permit compression and stretching of the inner jacket portion 14. The pores of inner jacket portion 14 are connected to each other durably such that stretching and compression of the inner jacket portion 14 does not break apart the pores of the inner jacket portion 14. The jacket pores may be sufficiently flexible to be compressed into gaps and voids between strands.

[0053] The molten material of the outer jacket portion 16 may cause melting or softening of the membranes of the pores. Control is exercised over the thickness of the lubrication and thickness of the inner jacket, pore size, and viscosity of the molten jacket to limit or control melting of the pores of the inner jacket and lubrication loss. Complete removal of lubrication is prevented.

[0054] The outside jacket in its finished state can be very thin, or not completely enclose the outer strans. In some embodiments, the outer top (known as ' hills') portion of the strands may not be covered by the outer jacket portion. In some embodiments, enough plastic is used for the outer plastic jacket material to fill the gaps between the outer strand knowns as the 'valleys' For example, a millimeter or less of the steel of the outer strands may extend radially outward beyond the outer jacket portion.

[0055] In an exemplary embodiment, a core with eight outer strands is lubricated. An inner jacket portion is cold applied around the core. The inner jacket portion is impregnated with a molten plastic outer jacket portion, and simultaneously additional outer strands are closed around the inner jacket portion forcing the inner jacket portion towards the and into the outer strands. The plastic outer jacket portion fills the pores of the inner jacket portion and the voids between strands and the application of the outer jacket portion is completed when the outer jacket portion reaches the outer surface of the additional outer strands. The completed wire rope goes through a wiping, cooling and smoothing machine.

What is claimed is:

1. A wire rope, comprising:
   a lubricated core;
   an inner jacket portion contacting the core;
   outer strands wrapped around the inner jacket portion; and
   an outer jacket portion surrounding the outer strands and contacting the inner jacket portion to form an integrated jacket.

2. The wire rope of claim 1 wherein the inner jacket portion is formed of a material with a first melting point, the outer jacket portion is formed of a material with a second melting point; and the melting point of the material of the inner jacket portion is higher than the melting point of the material of the outer jacket portion.

3. The wire rope of any one of claims 1 – 2 wherein the inner jacket portion is porous, and the outer jacket portion contacts the pores of the inner jacket portion.

4. The wire rope of any one of claims 1 – 2 wherein the inner jacket portion forms a matrix.

5. The wire rope of any one of claims 1 – 2 wherein the inner jacket portion is formed by crossing fibrous material.

6. The wire rope of any one of claims 1 – 2 wherein the inner jacket portion is formed by grids of material laid on top of each other.

7. The wire rope of any one of claims 1 – 2 wherein the inner jacket portion is formed from a material having undulations or waves.

8. The wire rope of any one of claims 1 – 7 wherein the inner jacket portion is permeable, and the outer jacket portion permeates at least partly into the inner jacket portion.

9. The wire rope of any one of claims 1 – 8 wherein material of the outer jacket portion fills gaps between outer strands.

10. The wire rope of any one of claims 1 – 9 wherein inner jacket portion at least partly fills gaps between outer strands.

11. The wire rope of any one of claims 1 – 10 wherein the inner jacket portion is compressible.

12. The wire rope of any one of claims 1 – 11 wherein the inner jacket portion is made of plastic.

13. The wire rope of any one of claims 1 – 12 wherein the inner jacket portion is made of metal.

14. The wire rope of any one of claims 1 – 13 wherein the core is an independent wire rope core.

15. The wire rope of any one of claims 1 – 14 wherein the outer strands or core strands or both outer strands and core strands or wires of the outer strands or of the core strands or of both outer strands and core strands are galvanized.

16. The wire rope of any one of claims 3 – 15 wherein the inner jacket portion has a porosity between 5 PPI and 50 PPI.

17. The wire rope of any one of claims 3 – 16 wherein the pores of the inner jacket portion have an open cell configuration.

18. The wire rope of any one of claims 1 – 17 wherein the inner jacket portion has a floor formed adjacent to the core.

19. The wire rope of claim 18 wherein the floor is an impermeable floor to trap lubrication within the core.

20. The wire rope of claim 18 wherein the floor has an open celled configuration.

21. The wire rope of claim 17 wherein the floor is slightly permeable.

22. The wire rope of claim 18 wherein the floor is porous, the porosity of the floor has a first porosity, the porosity of the inner jacket portion has a second porosity and the first porosity is different from the second porosity.

23. The wire rope of any one of claims 1 – 22 wherein the outer jacket portion is made of plastic.

24. The wire rope of claim 23 wherein the plastic of the outer jacket portion comprises polypropylene, polyethylene, polystyrene, nylon or tetrafluorethylene.

25. A method of constructing a wire rope from a core and outer strands, the core being lubricated, comprising:

applying an inner jacket portion by cold application to the core; and

closing the outer strands over the inner jacket portion while applying a molten material to the outer strands at a temperature and pressure sufficient to cause the molten material to contact the inner jacket portion to form an integrated jacket that includes the inner jacket portion, the inner jacket portion having an equal or higher melting point than the molten material.

26. A method of constructing a wire rope from a core and outer strands, the core being lubricated, comprising:

applying an inner jacket portion by cold application to the core, the inner jacket portion being permeable and having pores or voids; and

closing the outer strands over the inner jacket portion while applying a molten material to the outer strands at a temperature and pressure sufficient to cause the molten material to migrate into pores or voids of the inner jacket portion such that the molten material cools as the molten material passes through the pores of the inner jacket portion to form an integrated jacket that includes the inner jacket portion, the inner jacket portion having an equal or higher melting point than the molten material.

27. The method of any one of claims 25 and 26 further comprising compressing the inner jacket portion with the outer strands to fill gaps between the outer strands.

28. The method of any one of claims 25 – 27 wherein closing the outer strands is simultaneous with applying the molten material to the outer strands.

29. The method of any one of claims 25 – 27 wherein closing the outer strands is simultaneous with applying the molten material to the inner jacket portion.

30. The method of any one of claims 25 – 29 wherein the inner jacket is tubular prior to application to the core.

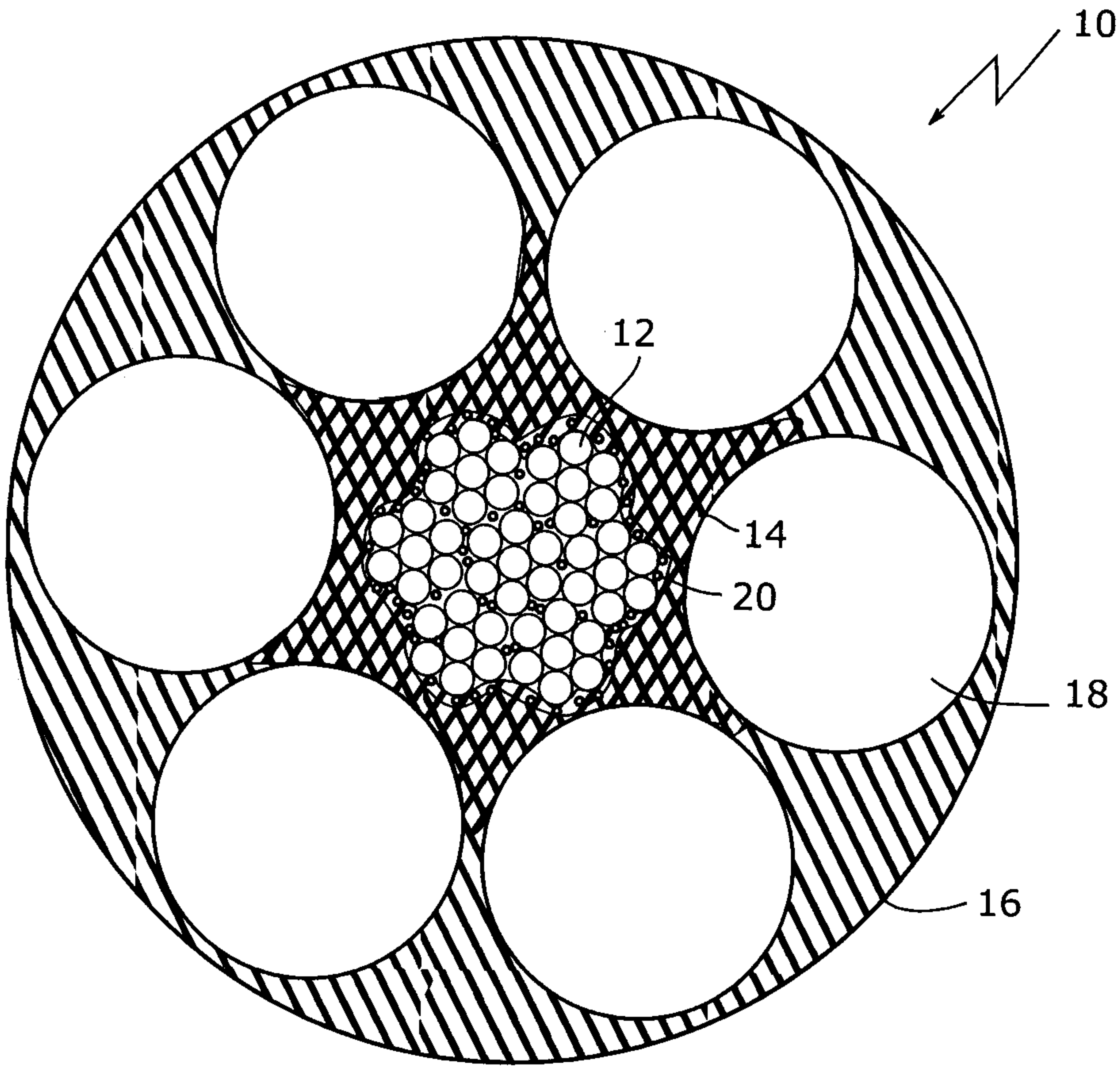


Fig. 1

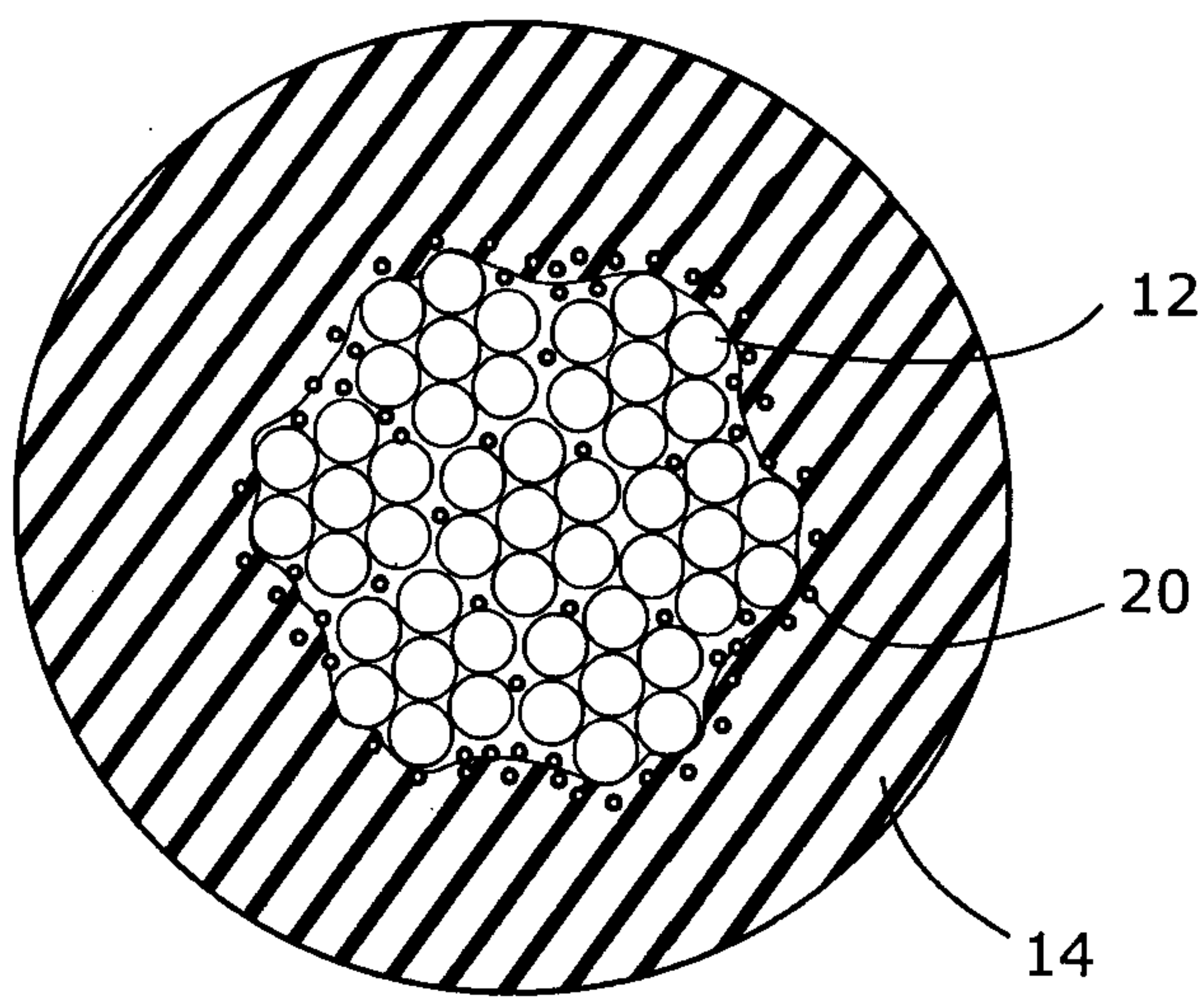


Fig. 2

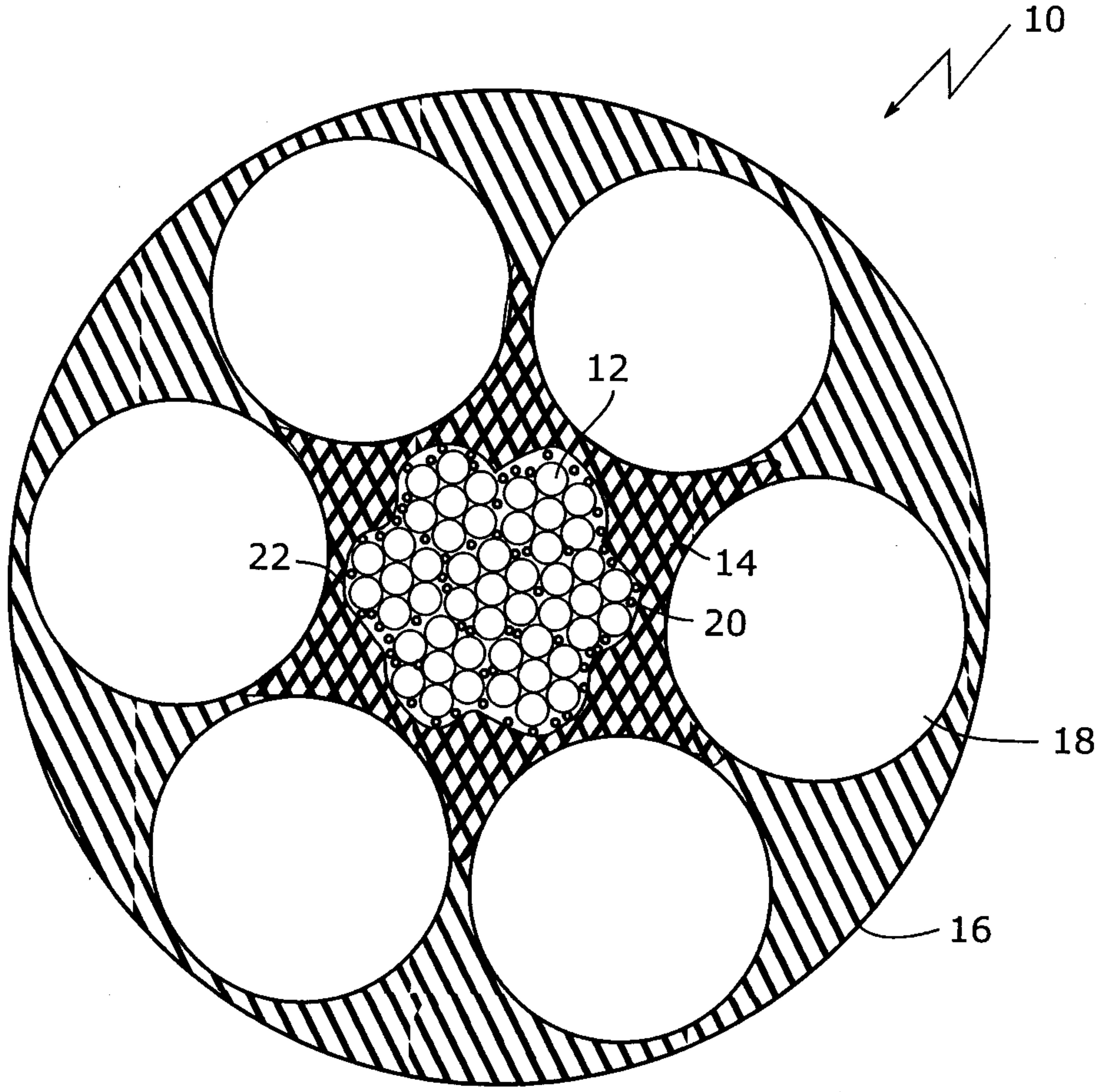


Fig. 3

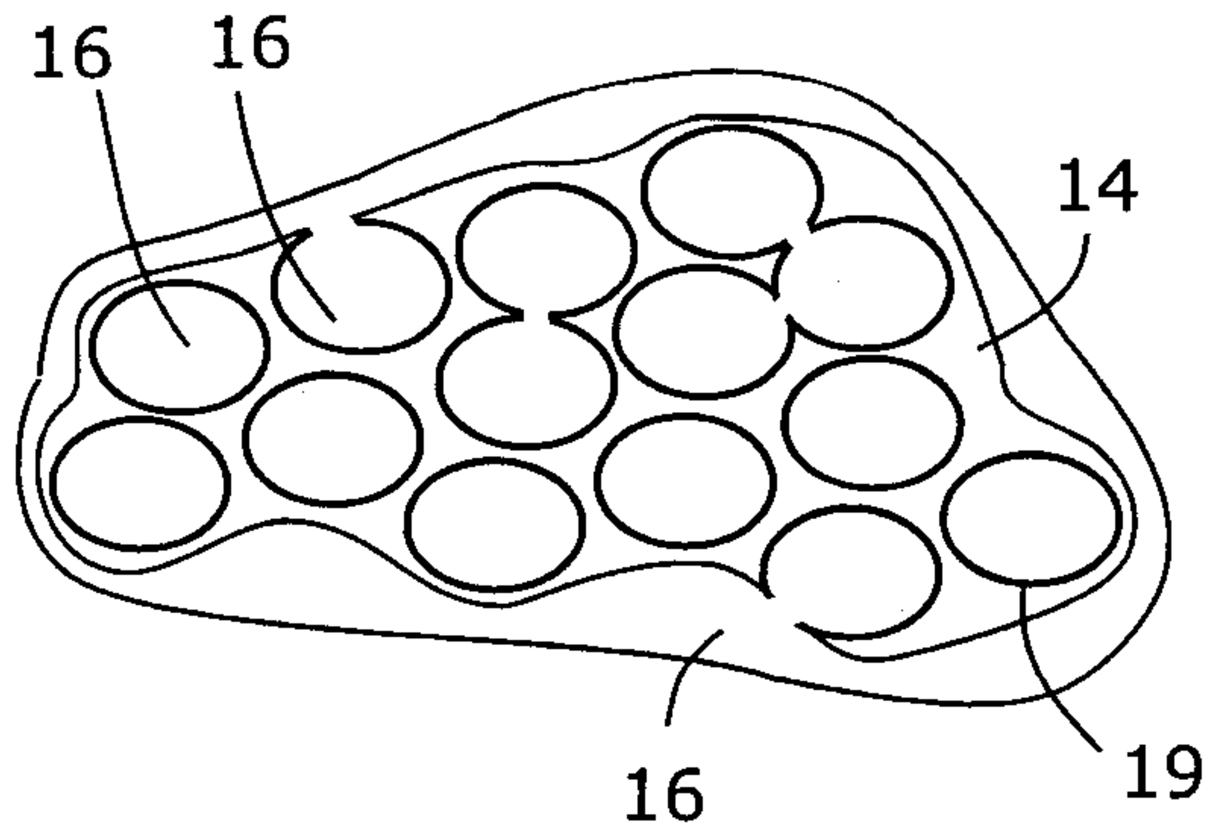


Fig. 4

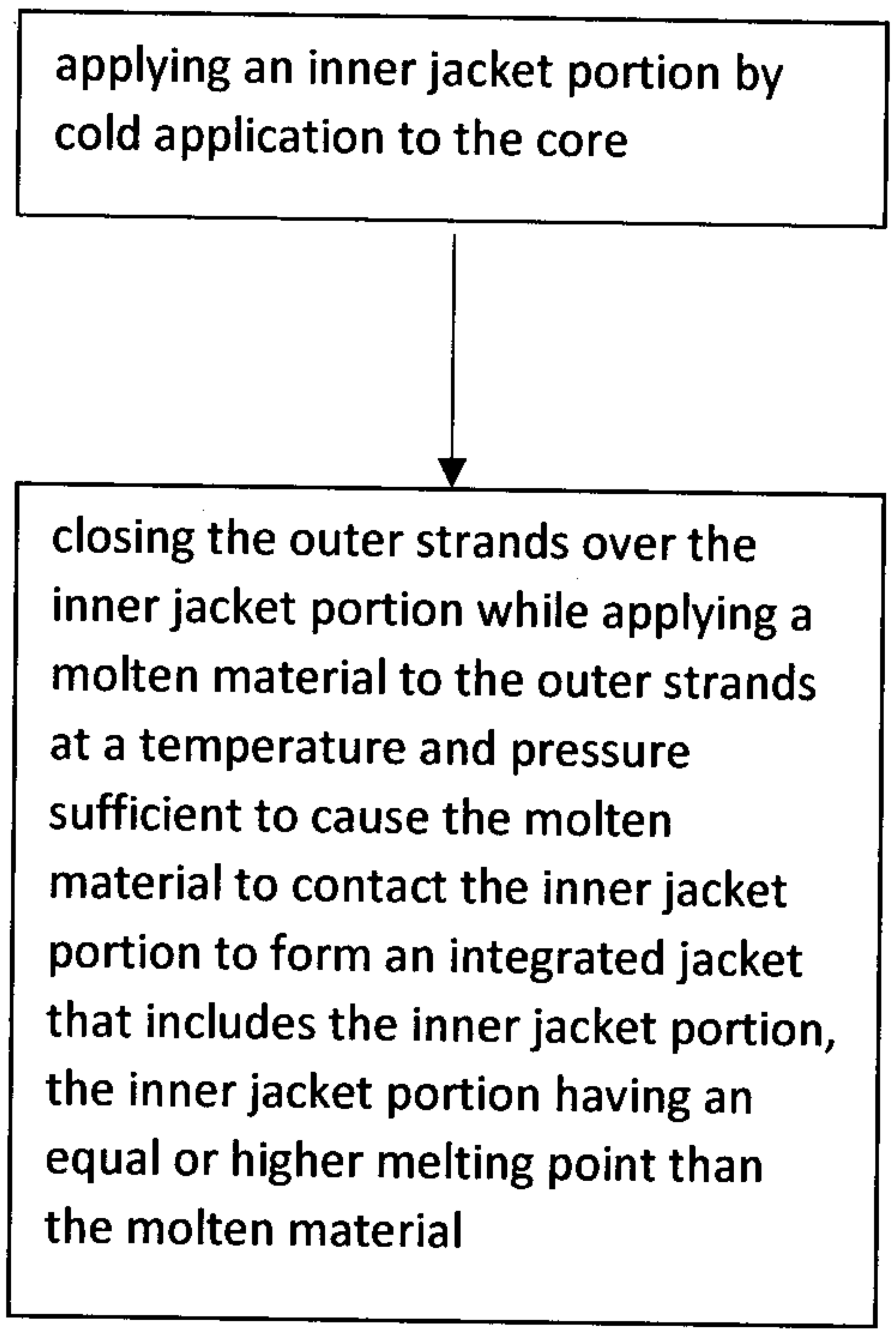

applying an inner jacket portion by cold application to the core
closing the outer strands over the inner jacket portion while applying a molten material to the outer strands at a temperature and pressure sufficient to cause the molten material to contact the inner jacket portion to form an integrated jacket that includes the inner jacket portion, the inner jacket portion having an equal or higher melting point than the molten material

Fig. 5

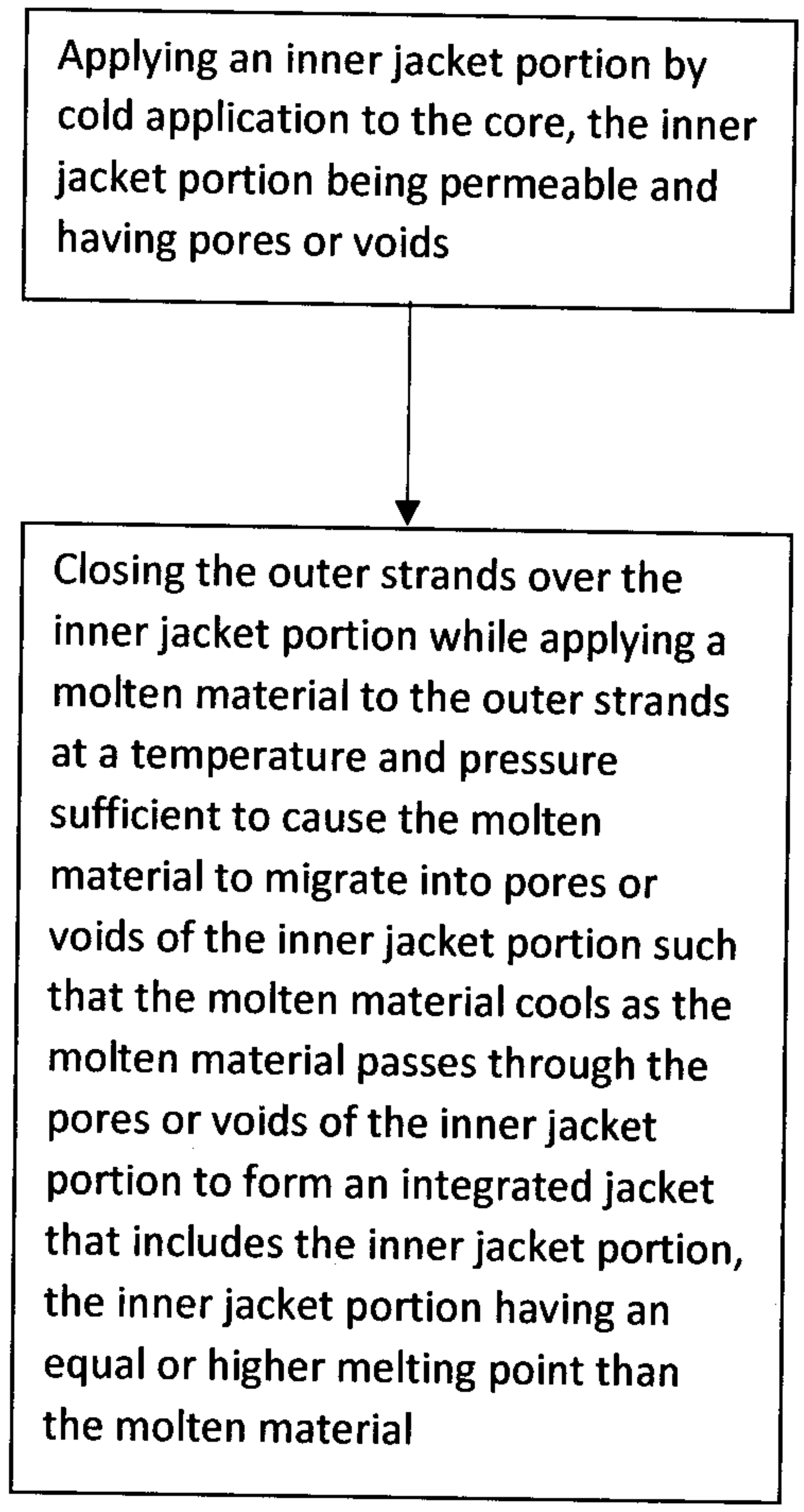

Applying an inner jacket portion by cold application to the core, the inner jacket portion being permeable and having pores or voids
Closing the outer strands over the inner jacket portion while applying a molten material to the outer strands at a temperature and pressure sufficient to cause the molten material to migrate into pores or voids of the inner jacket portion such that the molten material cools as the molten material passes through the pores or voids of the inner jacket portion to form an integrated jacket that includes the inner jacket portion, the inner jacket portion having an equal or higher melting point than the molten material

Fig. 6

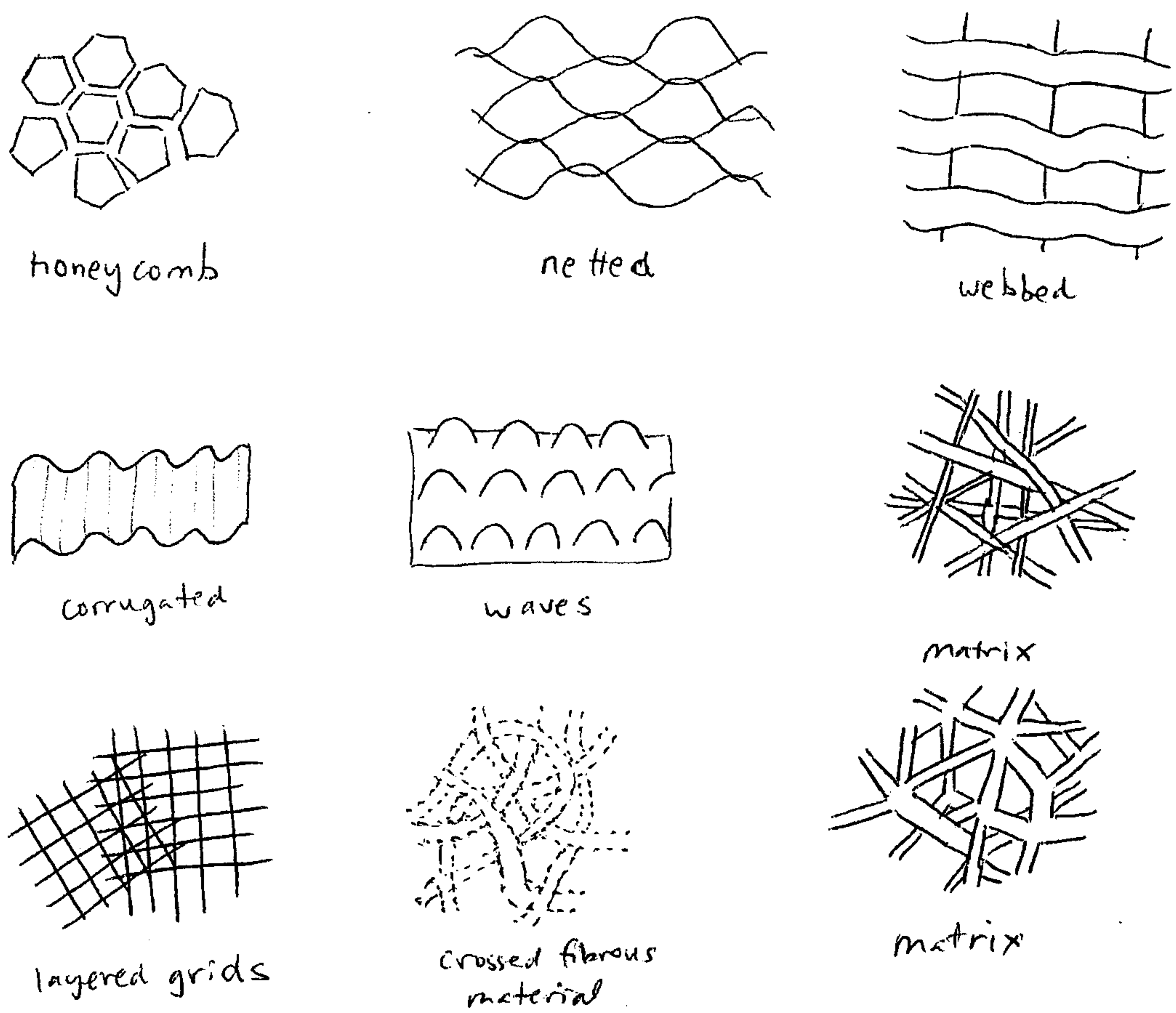
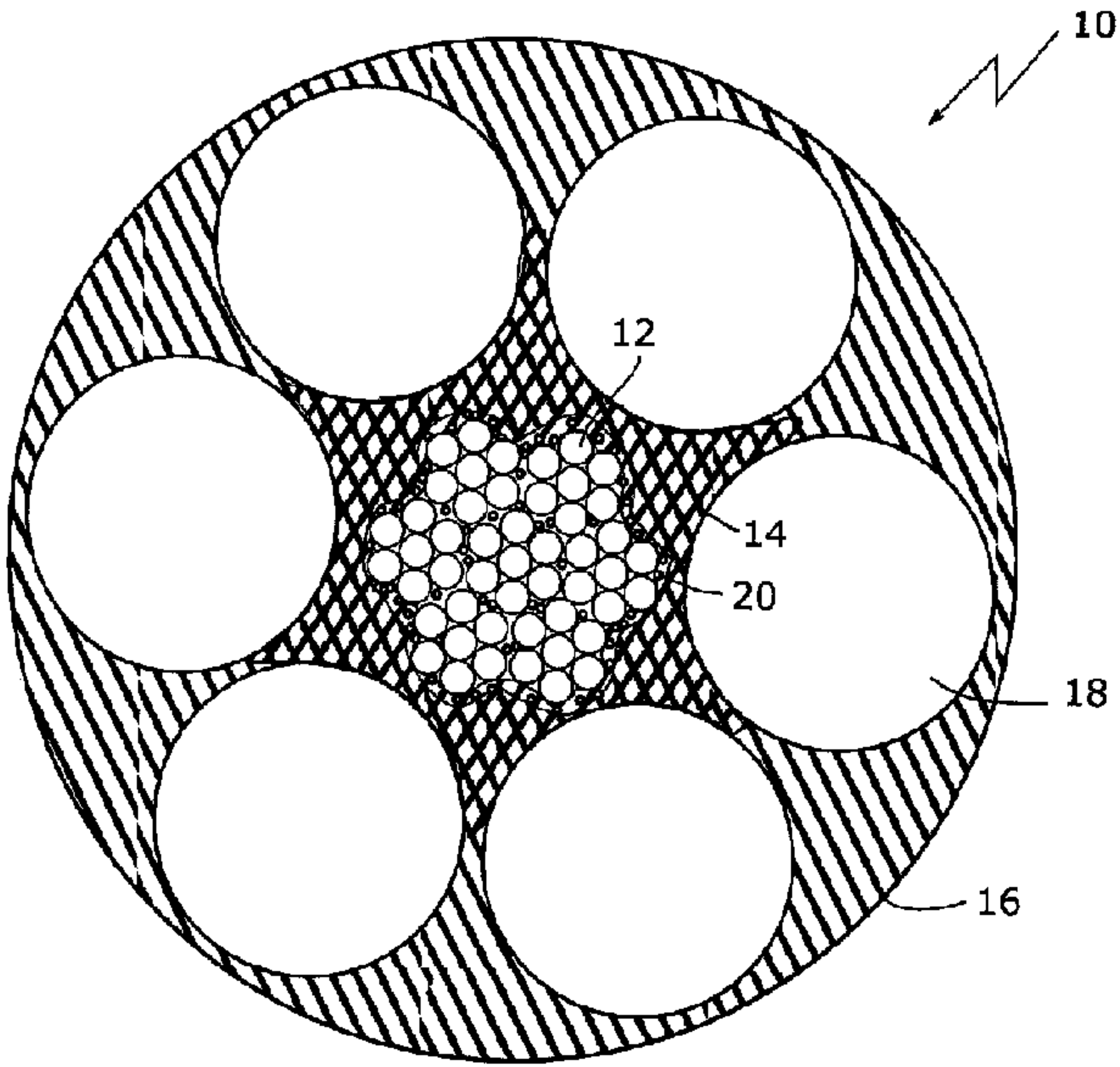

honeycomb
netted
webbed
corrugated
waves
matrix
layered grids
crossed fibrous material
matrix

Fig. 7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