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(54) THERMAL MANAGEMENT SHIRT

(57) A shirt includes a heat retaining fabric and a heat dissipating fabric. The heat retaining fabric (2, 9, 3a, 3b) is configured to be arranged in a portion of the front of the shirt that covers at least a part of the pectoralis major muscle, in an upper portion of the back of the shirt, and in portions of the shirt, each of which covers at least a part of the upper arm, when the shirt is worn. The heat dissipating fabric (8a, 8b, 5a, 5b) is configured to be arranged in portions of the back of the shirt, each of which extends from the shoulder, passes through the side of the dorsum, covers at least a part of the infraspinatus muscle, and is connected to the axillary region, when the shirt is worn. The heat retaining fabric (9) arranged in the upper portion of the back of the shirt is separated from the heat retaining fabric (3a, 3b) arranged in the portions of the shirt, each covering at least a part of the upper arm, by the heat dissipating fabric (8a, 8b, 5a, 5b) arranged in the portions of the back of the shirt, each extending from the shoulder, passing through the side of the dorsum, covering at least a part of the infraspinatus muscle, and being connected to the axillary region. With this configuration, the heat retaining fabric and the heat dissipating fabric are arranged respectively in the portions of the shirt that are to be used for heat retention and heat dissipation during a warm-up for sports.

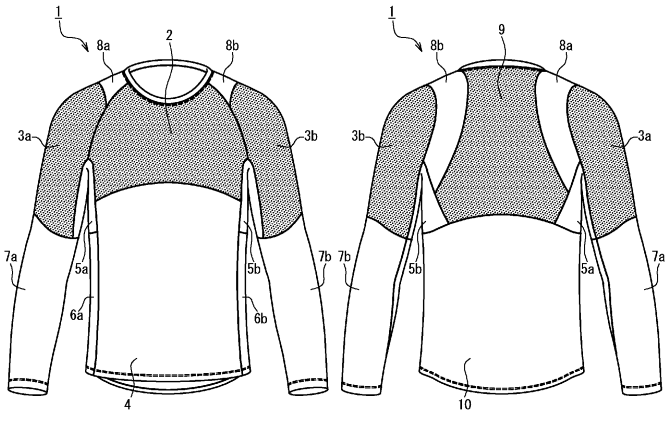

FIG. 1A FIG. 1B

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a shirt suitable for sports.

2. Description of Related Art

[0002] A shirt is a piece of clothing that is worn on the upper part of the human body. Shirts can be used as underwear, inner garments, etc. in daily life and are also suitable for sports activities. In many sports including, e.g., baseball, soccer, rugby, marathons, running, walking, cycling, mountain climbing, and tennis, warm-ups are essential to improve athletic performance. Patent Document 1 proposes a garment that has the function of keeping the legs warm. Patent Document 2 proposes a garment for the upper body that includes a heat retention region extending from the forearm to the hand, and a garment for the lower body that includes a heat retention region covering the buttocks and the hamstrings. Patent Document 3 proposes a leg wear that is made of a heat insulating material, but partially has a heat dissipating portion.

Prior Art Documents

Patent Documents

[0003]

Patent Document 1: JP 2005-248389 A
Patent Document 2: JP 2010-535296 A
Patent Document 3: JP 2020-133093 A

SUMMARY OF THE INVENTION

[0004] However, the above conventional techniques fail to make a proper distinction between the portion of clothing that should be designed to retain heat during exercise and the portion of the clothing that should be designed to dissipate heat during exercise. In this regard, further improvements are required in the conventional techniques.

[0005] To solve the conventional problems, the present invention provides a shirt that distinguishes the portion that is designed to retain heat during exercise from the portion that is designed to dissipate heat during exercise, in which a heat retaining fabric and a heat dissipating fabric are arranged in the portions of the shirt that are to be used for heat retention and heat dissipation, respectively.

[0006] The present invention relates to a shirt that includes a heat retaining fabric and a heat dissipating fabric. The heat retaining fabric (2, 9, 3a, 3b) is configured to be arranged in a portion of a front of the shirt that covers at least a part of the pectoralis major muscle, in an upper portion of a back of the shirt, and in portions of the shirt, each of which covers at least a part of the upper arm, when the shirt is worn. The heat dissipating fabric (8a, 8b, 5a, 5b) is configured to be arranged in portions of the back of the shirt, each of which extends from the shoulder, passes through the side of the dorsum, covers at least a part of the infraspinatus muscle, and is connected to the axillary region, when the shirt is worn. The heat retaining fabric (9) arranged in the upper portion of the back of the shirt is separated from the heat retaining fabric (3a, 3b) arranged in the portions of the shirt, each covering at least a part of the upper arm, by the heat dissipating fabric (8a, 8b, 5a, 5b) arranged in the portions of the back of the shirt, each extending from the shoulder, passing through the side of the dorsum, covering at least a part of the infraspinatus muscle, and being connected to the axillary region.

[0007] In the shirt of the present invention, the heat retaining fabric is configured to be arranged in the portion that covers at least a part of the pectoralis major muscle and the heat dissipating fabric is configured to be arranged in the portions, each of which covers at least a part of the axillary region, when the shirt is worn. With this configuration, the shirt can warm the agonist muscles during exercise to improve the power output of the muscles and to promote supercompensation, and at the same time it can dissipate heat from the heat dissipation areas of the body to reduce an increase in the core temperature. Consequently, the shirt allows the wearer to continue exercise without reducing the thermal comfort. Moreover, the shirt serves to shorten the warm-up time and also enables the body to prepare for taking part in a sport.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

[FIG. 1] FIGS. 1A and 1B are a schematic front view and a schematic back view of a shirt in an embodiment of the present invention, respectively.
[FIG. 2] FIGS. 2A and 2B are a schematic front view and a schematic back view of a shirt in another embodiment of the present invention, respectively.
[FIG. 3] FIGS. 3A and 3B are a schematic front view and a schematic back view of a shirt in another embodiment of the present invention, respectively.
[FIG. 4] FIGS. 4A and 4B are a schematic front view and a schematic back view of a shirt in another embodiment of the present invention, respectively.
[FIG. 5] FIG. 5 is a front view of the muscles of the upper part of the human body.
[FIG. 6] FIG. 6 is a back view of the muscles of the upper part of the human body.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Physical exercise is necessary to improve physical performance. During exercise, the temperature of muscles is increased, which may improve the power output of the muscles and promote supercompensation. Since muscles are composed of chemical substances, an increase in muscle temperature leads to a high energy state, in which a chemical reaction is accelerated so that neurotransmission and muscle movement can be enhanced. If the whole body is warmed up, the muscle temperature may be increased to improve the power output of the muscles and to promote supercompensation. However, warming up the whole body causes a rise in temperature inside the body (i.e., the core temperature), and the body feels hot. This may reduce the thermal comfort and result in low physical performance. Assuming that people continue to exercise while keeping the body warm, they can suffer heat syncope, heat cramps, heat exhaustion, or heatstroke due to the increased core temperature, and will find it difficult to do the exercise.

[0010] The present invention provides clothing that allows the wearer to continue exercise without reducing the thermal comfort. For this purpose, the clothing of the present invention can warm the agonist muscles during exercise to improve the power output of the muscles and to promote supercompensation, and at the same time it can dissipate heat from the heat dissipation areas of the body to reduce an increase in the core temperature.

[0011] The present invention relates to a shirt that includes a heat retaining fabric and a heat dissipating fabric. The heat retaining fabric is configured to be arranged in a portion of the shirt that covers at least a part of the pectoralis major muscle and the heat dissipating fabric is configured to be arranged in portions of the shirt, each of which covers at least a part of the axillary region, when the shirt is worn. The arrangement of the heat retaining fabric in the portion that covers at least a part of the pectoralis major muscle, which is the main muscle of the upper body, can improve physical performance for various movements. The arrangement of the heat dissipating fabric in the portions, each of which covers at least a part of the axillary region, can efficiently cool the heat dissipation area of the body where the axillary vein lies. The axillary vein is a large blood vessel located in the vicinity of the superior vena cava and passes near the skin surface. Accordingly, the axillary vein is likely to be affected by the heat dissipating fabric and can be efficiently cooled. This embodiment is effective for sleeveless shirts. The shirt of the present invention serves to shorten the warm-up time and also enables the body to prepare for taking part in a sport while saving enough energy for the sport. Any fabric used for a normal sports shirt may be arranged in the remaining portion of the shirt other than the heat retaining fabric portion and the heat dissipating fabric portion. The same is true for other examples of the shirt.

[0012] In the present invention, it is preferable that the heat retaining fabric is configured to be further arranged in portions of the shirt, each of which covers at least a part of the deltoid muscle, when the shirt is worn. This arrangement can improve physical performance for various movements. It is also preferable that the heat retaining fabric is configured to be further arranged in portions of the shirt, each of which covers at least a part of the biceps brachii muscle, and the heat retaining fabric is configured to be further arranged in portions of the shirt, each of which covers at least a part of the triceps brachii muscle, when the shirt is worn. The deltoid muscles, the biceps brachii muscles, and the triceps brachii muscles are mainly responsible for the movement of the upper limbs. Thus, the arrangement of the heat retaining fabric in the portions covering these muscles can improve the reactivity, operativity, and muscular strength of the upper limbs. This embodiment is effective for short-sleeved shirts, three-quarter sleeve shirts, and long-sleeved shirts.

[0013] In the present invention, it is preferable that the heat dissipating fabric is configured to be further arranged in portions of the back of the shirt, each of which extends from the shoulder, covers at least a part of the infraspinatus muscle, and is connected to the axillary region, when the shirt is worn. It is also preferable that the heat dissipating fabric is configured to be further arranged in a portion of the front of the shirt that covers the abdomen, when the shirt is worn. This arrangement can reduce an increase in the core temperature of the body. This embodiment is effective for sleeveless shirts, short-sleeved shirts, three-quarter sleeve shirts, and long-sleeved shirts.

[0014] In the present invention, it is preferable that the heat retaining fabric and the heat dissipating fabric are configured to be arranged in the upper portion and the lower portion of the back of the shirt, respectively, when the shirt is worn. With this configuration, the shirt can warm the agonist muscles during exercise to improve the power output of the muscles and to promote supercompensation, and at the same time it can dissipate heat from the heat dissipation areas of the body to reduce an increase in the core temperature. Consequently, the shirt allows the wearer to continue exercise without reducing the thermal comfort. It is more preferable that the heat retaining fabric is configured to be arranged in a portion of the back of the shirt that covers at least a part of the trapezius muscle and the heat dissipating fabric is configured to be arranged in a portion of the back of the shirt that covers at least a part of the fascia thoracolumbalis, when the shirt is worn. This embodiment is effective for sleeveless shirts, short-sleeved shirts, three-quarter sleeve shirts, long-sleeved shirts, and warm-up shirts.

[0015] In the present invention, the space between the skin and the inner surface of the clothing is preferably as small as possible. The space is preferably 20 mm or less, and more preferably 10 mm or less. Alternatively, the inner surface of the clothing may be in direct contact with the skin. Thus, the muscles in the desired region can

easily be warmed by the heat retaining fabric while reducing heat loss.

[0016] The heat retaining fabric preferably has water absorbability. When the muscle temperature is increased, sweat (in the liquid phase) comes out on the skin surface. A lack of water absorbability is undesirable because sweat may remain on the skin surface and absorb heat from the muscles, resulting in a decrease in the muscle temperature. The water absorbability is preferably 60 seconds or less, and more preferably 30 seconds or less, as measured in accordance with JIS L 1907 (dropping method).

[0017] The heat retaining fabric covers preferably 50% or more, and more preferably 70% or more of the specified muscle in the body region when the shirt is worn. This ensures that the main part of the specified muscle becomes warm. In the present specification, the specified muscle represents the belly of the muscle and does not include the tendon of the muscle.

[0018] The amount of heat dissipation of the heat retaining fabric is preferably as small as possible. The amount of heat dissipation is preferably 2.0 W or less, and more preferably 1.8 W or less. The amount of heat dissipation is determined by measuring the power consumption of an evaluation device for heat retention properties ("KES-F7" manufactured by KATO TECH CO., LTD.) in accordance with JIS L 1927, where ΔT is set to 20°C. In this case, the power consumption can be used to quantify the phenomenon of heat dissipation through the fabric. The smaller the value of the power consumption, the better the ability of the fabric to keep warmth.

[0019] Preferred examples of the heat retaining fabric include the following.

(1) Moisture-absorbent heat-generating fabric

[0020] A moisture-absorbent heat-generating fabric contains highly crosslinked polyacrylate fibers. The highly crosslinked polyacrylate fibers alone can generate enough heat to burn the skin, and therefore are usually blended with polyester fibers so that the amount of the highly crosslinked polyacrylate fibers is 10 to 40% by mass. Then, the blended fibers are twisted together to form a spun yarn. The spun yarn is used to make a woven or knitted fabric. The moisture-absorbent heat-generating fabric is now on the market as a trade name "BREATH THERMO" manufactured by Mizuno Corporation.

(2) Fabric containing fiber with low thermal conductivity

[0021] Fibers with low thermal conductivity include, e.g., wool, nylon, and polyester whose thermal conductivities are 0.19, 0.22, and 0.25 kcal $m^{-1}h^{-1}°C^{-1}$, respectively (Fiber Handbook, Third Edition, edited by the Society of Fiber Science and Technology, Japan, published by MARUZEN Co., Ltd., December 15, 2004, page 462). The fibers with low thermal conductivity may also include polypropylene whose thermal conductivity is 0.12 W/m·°C (Plastic Data Book, published by Kogyo Chosakai Publishing Co., Ltd., January 20, 2006, page 60).

(3) Fabric containing heat storage fiber

[0022] Heat storage fibers are produced by incorporating a heat storage material into a polymer and spinning the mixture. Examples of the heat storage material include ceramic particles, graphite silica powder, volcanic ash, and tungsten powder.

(4) Fluffy fabric

[0023] A fluffy fabric may be, e.g., a boa fabric, a pile fabric, a raised fabric, a stitched double fabric, or a stretchy knitted fabric made of a false twist crimped yarn.

(5) Point-contact fabric

[0024] A point-contact fabric makes point contact with the skin of the human body. This structure can be formed by, e.g., weaving, knitting, or embossing.

(6) Vapor-deposited fabric having radiation effect

[0025] A vapor-deposited fabric having a radiation effect may be produced by depositing meal such as aluminum on fibers or fabric.

(7) Fabric with low breathability

[0026] A fabric with low breathability preferably has an air permeability of 150 $cm^3/cm^2 \cdot sec$ or less, as measured in accordance with JIS L 1096 (Frajour method). Heat retention increases with a decrease in air permeability. However, if the air permeability of a fabric is too low, the fabric becomes sticky when wet. Therefore, the lower limit of the air permeability is preferably 1 $cm^3/cm^2 \cdot sec$ or more.

[0027] The above fabrics may be used alone or in combination of two or more.

[0028] The heat dissipating fabric is configured to be arranged in a portion of the shirt that covers at least a part of the axillary vein. The axillary vein is connected to the superior vena cava, which is one of the largest blood vessels just below the heart. When the axillary vein is cooled by the heat dissipating fabric, the blood flowing through it is also cooled. The cooled blood efficiently returns to the heart, which helps to prevent an increase in the core temperature. The axillary vein may be cooled by the outside air if it is not covered with the shirt. The heat dissipating fabric covers preferably 50% or more, and more preferably 70% or more of the specified muscle in the body region when the shirt is worn. This ensures that heat can be efficiently released from the main part of the specified muscle. The amount of heat dissipation of the heat dissipating fabric is preferably as large as possible. The amount of heat dissipation is preferably

1.0 W or more, and more preferably 1.2 W or more. The amount of heat dissipation is determined by measuring the power consumption of an evaluation device for heat retention properties ("KES-F7" manufactured by KATO TECH CO., LTD.) in accordance with JIS L 1927, where ΔT is set to 20°C. In this case, the power consumption can be used to quantify the phenomenon of heat dissipation through the fabric. The larger the value of the power consumption, the better the ability of the fabric to dissipate heat.

[0029] Preferred examples of the heat dissipating fabric include the following.

(1) Fabric containing quick-drying fiber

[0030] A fabric containing quick-drying fibers may be, e.g., a water-absorbent quick-drying polyester fabric. This fabric allows moisture such as sweat to evaporate easily and dissipates the body heat due to latent heat of evaporation of the moisture. The water-absorbent quick-drying polyester fabric may be obtained by, e.g., treating fibers with a hydrophilic polyester resin. A hydrophilic polyester resin treatment agent to be used has the same function as a disperse dye, and at least a part of the treatment agent is absorbed in the fibers (exhaustive diffusion). The hydrophilic polyester resin treatment agent may contain a linear copolymer, and preferably a block copolymer, in which the polyester end groups and the hydrophilic end groups are bonded to each other. The molecular weight is preferably 5000 to 8000, and more preferably 6000 to 7000. The polymerization ratio of the polyester group to the hydrophilic group is preferably 90/10 to 10/90, and more preferably 60/40 to 20/80. The hydrophilic group may be, e.g., polyethylene glycol, sodium 5-sulfoisophthalate, or trimellitic anhydride, and is more preferably polyethylene glycol. Such a treatment agent may be, e.g., KMZ-902 (product number) manufactured by TAKAMATSU OIL & FAT CO., LTD.

[0031] The water absorbability is preferably 20 seconds or less, and more preferably 10 seconds or less, as measured in accordance with JIS L 1907 (dropping method). The quick-drying properties are evaluated in accordance with ISO 17617-2014 A1, and the drying time is preferably 80 minutes or less, and more preferably 70 minutes or less. The fabric with these features absorbs and diffuses moisture away from the skin, dries quickly, and dissipates the body heat due to latent heat of evaporation of the moisture, thereby keeping the fabric temperature low.

(2) Fabric containing fiber with high thermal conductivity

[0032] Fibers with high thermal conductivity include, e.g., cotton with a thermal conductivity of 0.56 kcal $m^{-1}h^{-1}°C^{-1}$ and rayon having about the same thermal conductivity as cotton (Fiber Handbook, Third Edition, edited by the Society of Fiber Science and Technology, Japan, published by MARUZEN Co., Ltd., December 15, 2004, page 462). The fibers with high thermal conductivity may also include polyethylene whose thermal conductivity is 0.33 W/m·°C for LDPE and 0.46 to 0.50 W/m·°C for HDPE (Plastic Data Book, published by Kogyo Chosakai Publishing Co., Ltd., January 20, 2006, page 60). Moreover, ethylene vinyl alcohol fibers derived from ethylene fibers may also be used, which are now on the market as a trade name "SOPHISTA" manufactured by Kuraray Co., Ltd.

(3) Thin fabric

[0033] A fabric with a relatively small thickness compared to the heat retaining fabric may also be used. The thickness of the heat dissipating fabric is preferably at least 0.1 mm, more preferably at least 0.13 mm, and further preferably at least 0.15 mm smaller than that of the heat retaining fabric.

(4) Fabric with high breathability

[0034] A fabric with high breathability preferably has an air permeability of 100 $cm^3/cm^2·sec$ or more, as measured in accordance with JIS L 1096 (Frajour method). Heat dissipation increases with an increase in air permeability. However, if the air permeability of a fabric is too high, the strength of the fabric is reduced. Therefore, the upper limit of the air permeability is preferably 500 $cm^3/cm^2·sec$ or less.

(5) Fabric containing cooling fiber

[0035] Cellulose fibers such as cotton and rayon are hydrophilic fibers and have the property that once the fibers absorb moisture, they do not release it. Moreover, the cellulose fibers are cold when wet. For this reason, a fabric containing these cooling fibers may also be used.

[0036] The above fabrics may be used alone or in combination of two or more. In particular, the water-absorbent quick-drying polyester fabric is preferred.

[0037] The heat retaining fabric and the heat dissipating fabric preferably have the following relationship.

(1) Difference in thickness: heat retaining fabric - heat dissipating fabric > 0.1 mm

[0038] A thick fabric is likely to trap dead air, which can enhance the thermal insulation properties of clothing. When the heat retaining fabric is thicker than the heat dissipating fabric, heat is not easily transferred from the inside to the outside of clothing. This configuration can increase the muscle temperature and also reduce an increase in the core temperature of the body. If the thickness difference is 0.1 mm or less, a difference in thermal insulation performance between the two fabrics becomes small, and it may not be possible to appropriately increase the muscle temperature or to maintain the core temperature. Clothing can be designed to be adaptable

to the environment by reducing the thickness of both the heat retaining fabric and the heat dissipating fabric in a hot environment and by increasing the thickness of both the heat retaining fabric and the heat dissipating fabric in a cold environment. In addition, setting the difference in the thickness between the heat retaining fabric and the heat dissipating fabric to more than 0.1 mm can impart functionality to the clothing.

(2) Difference in amount of heat dissipation: heat dissipating fabric - heat retaining fabric > 0.3 W

[0039] The amount of heat dissipation is determined by measuring the power consumption of an evaluation device for heat retention properties ("KES-F7" manufactured by KATO TECH CO., LTD.) in accordance with JIS L 1927, where ΔT is set to 20°C. In this case, the power consumption can be used to quantify the phenomenon of heat dissipation through the fabric. The larger the value of the power consumption, the better the ability of the fabric to dissipate heat. If the difference in the amount of heat dissipation is 0.3 W or less, it may not be possible to appropriately increase the muscle temperature or to maintain the core temperature. Clothing can be designed to be adaptable to the environment by increasing the amount of heat dissipation of both the heat retaining fabric and the heat dissipating fabric in a hot environment and by reducing the amount of heat dissipation of both the heat retaining fabric and the heat dissipating fabric in a cold environment. In addition, setting the difference in the amount of heat dissipation between the heat retaining fabric and the heat dissipating fabric to more than 0.3 W can impart functionality to the clothing.

(3) Difference in air permeability: heat dissipating fabric - heat retaining fabric > 50 $cm^3/cm^2 \cdot sec$

[0040] The air permeability is determined by the air permeability test in accordance with JIS L 1096. Heat dissipation increases with an increase in air permeability because air can easily pass through the fabric. If the difference in the air permeability is 50 $cm^3/cm^2 \cdot sec$ or less, it may not be possible to appropriately increase the muscle temperature or to maintain the core temperature. Clothing can be designed to be adaptable to the environment by increasing the air permeability of both the heat retaining fabric and the heat dissipating fabric in a hot environment and by reducing the air permeability of both the heat retaining fabric and the heat dissipating fabric in a cold environment. In addition, setting the difference in the air permeability between the heat retaining fabric and the heat dissipating fabric to more than 50 $cm^3/cm^2 \cdot sec$ can impart functionality to the clothing.

[0041] (4) In particular, a combination of the moisture-absorbent heat-generating fabric containing highly crosslinked polyacrylate fibers (i.e., the heat retaining fabric) and the water-absorbent quick-drying polyester fabric (i.e., the heat dissipating fabric) is preferably used. The human body produces moisture in the form of perspiration on the skin surface during exercise. The moisture-absorbent heat-generating fabric absorbs the moisture and converts it into heat, and thus can achieve high heat retention performance. On the other hand, the water-absorbent quick-drying polyester fabric absorbs the moisture and allows it to evaporate, and thus can achieve high heat dissipation performance due to latent heat of evaporation of the moisture.

[0042] In the shirt of the present invention, the space between the skin and the inner surface of the clothing is preferably 20 mm or less, and more preferably 10 mm or less. Alternatively, the inner surface of the clothing may be in direct contact with the skin. Thus, the muscles in the desired region can easily be warmed by the heat retaining fabric while reducing heat loss. Moreover, heat dissipation through blood flow in the desired region can be accelerated by the heat dissipating fabric, thereby reducing an increase in the core temperature.

[0043] There are several ways of producing the clothing of the present invention. For example, the clothing can be made by sewing pieces of the heat retaining fabric and the heat dissipating fabric together. Alternatively, the entire clothing may be made of the heat dissipating fabric, and a piece of the heat retaining fabric may be sewed on the target portion of this clothing. Moreover, the entire clothing may be made of the heat retaining fabric, and part of the fabric surface that corresponds to the target portion of the clothing may be melted or cut. The pieces of fabric may be joined together, e.g., by stitching, hot-melt adhesive, or welding.

[0044] A garment that fits tightly to the body, leaving almost no space inside the garment, is called a compression garment. The compression garment can efficiently maintain the muscle temperature and increase blood flow for heat dissipation. The shirt of the present invention may be provided as a compression-type shirt. In such a case, the fabric that will cover a larger area of the body surface should have better stretchability. The stretchability of the fabric is determined by measuring an elongation rate in accordance with JIS L 1096 8.14.1 A, where the load is 17.6 N and the tensile speed is 200 mm/min. The fabric with an elongation rate of 50% or more in the body width direction may be suitable for the compression-type shirt. This is because if the size of the compression-type shirt is equal to or slightly smaller than the body size, the shirt allows for free movement, even though it is tight fitting. The shirt of the present invention may also be loose fitting (as compared to the compression garment) so that the space between the skin and the inner surface of the clothing is 20 mm or less. In this case, the stretchability of the fabric can be determined by the above manner, and the elongation rate is preferably 10% or more in the body width direction.

[0045] The shirt of the present invention is preferably used for sports. Preferred examples of the shirt include a sleeveless shirt, a short-sleeved shirt, a three-quarter sleeve shirt, a long-sleeved shirt, and a warm-up shirt.

The shirt of the present invention may be made by sewing pieces of the heat retaining fabric and the heat dissipating fabric, and optionally pieces of common shirt fabric, together. Alternatively, the entire structure of the shirt may be made of the heat dissipating fabric, and a piece of the heat retaining fabric may be attached to or sewed on the target portion of the shirt.

[0046] Hereinafter, the present invention will be described with reference to the drawings. In the following drawings, the same components are denoted by the same reference numerals. FIGS. 1A and 1B are a schematic front view and a schematic back view of a long-sleeved shirt in an embodiment of the present invention, respectively. A long-sleeved shirt 1 includes a heat retaining fabric and a heat dissipating fabric. Specifically, the heat retaining fabric 2 is configured to be arranged in a portion of the front of the shirt that covers the chest, i.e., the pectoralis major muscle. The heat retaining fabric 3a, 3b is configured to be arranged in portions of the shirt, each of which extends from the upper arm to the shoulder and covers at least a part of the deltoid muscle, at least a part of the biceps brachii muscle, and at least a part of the triceps brachii muscle. The heat dissipating fabric 4 is configured to be arranged in a portion of the front of the shirt that is lower than the chest and covers the abdomen. The heat dissipating fabric 5a, 5b is configured to be arranged in portions of the shirt, each of which covers the axillary region. The heat dissipating fabric 6a, 6b is configured to be arranged in portions of the shirt, each of which covers the lateral region. The heat dissipating fabric 7a, 7b is configured to be arranged in portions of the shirt, each of which covers the forearm. The heat dissipating fabric 8a, 8b is configured to be arranged in portions of the back of the shirt, each of which extends from the shoulder, covers a part of the infraspinatus muscle, and is connected to the axillary region. The heat retaining fabric 9 and the heat dissipating fabric 10 are configured to be arranged in the upper portion and the lower portion of the back of the long-sleeved shirt 1, respectively. The pieces (parts) of the heat retaining fabric and the pieces (parts) of the heat dissipating fabric are joined together by sewing. The configuration in FIG. 1 is similar to those in FIGS. 3 and 4.

[0047] FIGS. 2A and 2B are a schematic front view and a schematic back view of a long-sleeved shirt in another embodiment of the present invention, respectively. A long-sleeved shirt 11 includes a heat retaining fabric and a heat dissipating fabric. As illustrated in FIGS. 2A and 2B, the entire structure of the long-sleeved shirt 11 is made of the heat dissipating fabric 15, and pieces of the heat retaining fabric may be attached to the target portions of the shirt. Specifically, the heat retaining fabric 12a, 12b is configured to be arranged in portions of the front of the shirt, each of which covers the pectoralis major muscle. The heat retaining fabric 13a, 13b is configured to be arranged in portions of the shirt, each of which extends from the upper arm to the shoulder and covers the deltoid muscle. The heat retaining fabric 14a, 14b is configured to be arranged in portions of the shirt, each of which covers the biceps brachii muscle.

[0048] Moreover, the heat retaining fabric 16 is configured to be arranged in the upper portion of the back of the shirt. The heat retaining fabric 17a, 17b is configured to be arranged in portions of the shirt, each of which covers the triceps brachii muscle.

[0049] FIGS. 2A to 2B represent the inner side of the shirt that comes into contact with the skin, and no sea-island pattern appears on the outer side of the shirt.

[0050] FIGS. 3A and 3B are a schematic front view and a schematic back view of a short-sleeved shirt in another embodiment of the present invention, respectively. A short-sleeved shirt 18 includes a heat retaining fabric and a heat dissipating fabric. Specifically, the heat retaining fabric 19 is configured to be arranged in a portion of the front of the shirt that covers the chest, i.e., the pectoralis major muscle. The heat retaining fabric 20a, 20b is configured to be arranged in portions of the shirt, each of which extends from the upper arm to the shoulder and covers at least a part of the deltoid muscle, at least a part of the biceps brachii muscle, and at least a part of the triceps brachii muscle. The heat dissipating fabric 21 is configured to be arranged in a portion of the front of the shirt that is lower than the chest and covers the abdomen. The heat dissipating fabric 22a, 22b is configured to be arranged in portions of the shirt, each of which covers the axillary region. The heat dissipating fabric 23a, 23b is configured to be arranged in portions of the shirt, each of which covers the lateral region. The heat dissipating fabric 24a, 24b is configured to be arranged in portions of the back of the shirt, each of which extends from the shoulder, covers a part of the infraspinatus muscle, and is connected to the axillary region.

[0051] Moreover, the heat retaining fabric 25 and the heat dissipating fabric 26 are configured to be arranged in the upper portion and the lower portion of the back of the short-sleeved shirt 18, respectively.

[0052] FIGS. 4A and 4B are a schematic front view and a schematic back view of a sleeveless shirt in another embodiment of the present invention, respectively. A sleeveless shirt 27 includes a heat retaining fabric and a heat dissipating fabric. Specifically, the heat retaining fabric 28 is configured to be arranged in a portion of the front of the shirt that covers the chest, i.e., the pectoralis major muscle. The heat retaining fabric 29a, 29b is configured to be arranged in portions of the shirt, each of which covers at least a part of the deltoid muscle. The heat dissipating fabric 30 is configured to be arranged in a portion of the front of the shirt that is lower than the chest and covers the abdomen. The heat dissipating fabric 31a, 31b is configured to be arranged in portions of the shirt, each of which covers the axillary region. The heat dissipating fabric 32a, 32b is configured to be arranged in portions of the shirt, each of which covers the lateral region. The heat dissipating fabric 33a, 33b is configured to be arranged in portions of the back of the shirt, each of which extends from the shoulder, covers a part

of the infraspinatus muscle, and is connected to the axillary region.

[0053] Moreover, the heat retaining fabric 34 and the heat dissipating fabric 35 are configured to be arranged in the upper portion and the lower portion of the back of the sleeveless shirt 27, respectively.

[0054] FIGS. 5 and 6 are a front view and a back view of the muscles of the upper part of the human body, respectively. FIG. 5 and 6 are reference diagrams that represent the positional relationship between the heat retaining fabric and the heat dissipating fabric of the present invention.

Examples

[0055] The present invention will be described in more detail by way of examples. However, the present invention should not be interpreted solely by the following examples.

<Method for measuring air permeability>

[0056] The air permeability was measured in accordance with JIS L 1096 A (Frajour method).

<Method for measuring amount of heat dissipation>

[0057] The amount of heat dissipation was determined by measuring the power consumption of an evaluation device for heat retention properties ("KES-F7" manufactured by KATO TECH CO., LTD.) in accordance with JIS L 1927, where ΔT was set to 20°C.

<Method for measuring stretchability>

[0058] The stretchability was measured at a load of 17.6 N and a tensile speed of 200 mm/min in accordance with JIS L 1096 8.14.1 A.

(Example 1)

Heat retaining fabric A

[0059] A heat retaining fabric A was a circular-knitted fabric composed of 90% by mass of polyethylene terephthalate (PET) fibers and 10% by mass of highly crosslinked polyacrylate fibers. The yarns used were (i) a PET false twist yarn having a yarn fineness of 83 dtex and 48 filaments, (ii) a PET false twist yarn having a yarn fineness of 55 dtex and 24 filaments, and (iii) a spun yarn with a metric count of 40 (i.e., a blended yarn of 70% by mass of PET fibers and 30% by mass of highly crosslinked polyacrylate fibers). The circular-knitted fabric had a mass per unit area of 130 g/m^2, a thickness of 0.7 mm, a heat dissipation amount of 0.8 W, an air permeability of 130 cm^3/cm^2·sec, and a stretchability of 30%.

Heat dissipating fabric A

[0060] A heat dissipating fabric A was a circular-knitted fabric composed of 100% by mass of polyester fibers. The yarns used were (i) a PET false twist yarn having a yarn fineness of 83 dtex and 48 filaments and (ii) a PET false twist yarn having a yarn fineness of 83 dtex and 36 filaments. The fabric was knitted from these yarns and subjected to a water-absorbent quick-drying treatment. In the water-absorbent quick-drying treatment, the knitted fabric was immersed in a 5% o.w.f. (on the weight of fiber) aqueous solution of KMZ-902 (product number) manufactured by TAKAMATSU OIL & FAT CO., LTD., and the temperature was increased from room temperature to 130°C at 2°C/min. Then, the knitted fabric was treated at 130°C for 60 minutes, followed by cooling, washing with water, drying, tentering, and heat setting. The resulting circular-knitted fabric had a mass per unit area of 115 g/m^2, a thickness of 0.5 mm, a heat dissipation amount of 1.2 W, an air permeability of 200 cm^3/cm^2·sec, and a stretchability of 40%.

Production of clothing

[0061] A long-sleeved shirt was made by sewing pieces of the heat retaining fabric A and the heat dissipating fabric A together so that the heat retaining fabric A and the heat dissipating fabric A were arranged in their respective portions of the shirt, as indicated by FIG. 1. The space between the skin and the inner surface of the clothing was 20 mm.

(Example 2)

Heat retaining fabric B

[0062] A heat retaining fabric B was a circular-knitted fabric composed of 87% by mass of PET fibers, 10% by mass of highly crosslinked polyacrylate fibers, and 3% by mass of polyurethane fibers. The yarns used were (i) a PET false twist yarn having a yarn fineness of 83 dtex and 48 filaments, (ii) a polyurethane yarn having a yarn fineness of 33 dtex, and (iii) a spun yarn with a metric count of 40 (i.e., a blended yarn of 70% by mass of PET fibers and 30% by mass of highly crosslinked polyacrylate fibers). The circular-knitted fabric had a mass per unit area of 150 g/m^2, a thickness of 0.9 mm, a heat dissipation amount of 1.1 W, an air permeability of 100 cm^3/cm^2·sec, and a stretchability of 80%.

Heat dissipating fabric B

[0063] A heat dissipating fabric B was a warp-knitted fabric composed of 97% by mass of polyester fibers and 3% by mass of polyurethane fibers. The yarns used were (i) a PET false twist yarn having a yarn fineness of 83 dtex and 48 filaments and (ii) a polyurethane yarn having a yarn fineness of 33 dtex. The fabric was knitted from

these yarns and subjected to a water-absorbent quick-drying treatment in the same manner as Example 1. The resulting warp-knitted fabric had a mass per unit area of 160 g/m^2, a thickness of 0.6 mm, a heat dissipation amount of 2.0 W, an air permeability of 150 cm^3/cm^2·sec, and a stretchability of 120%.

Production of clothing

[0064] A long-sleeved shirt was made by using the heat dissipating fabric B to form the entire structure of the shirt, and then attaching pieces of the heat retaining fabric B to the portions of the shirt, as indicated by FIG. 2. The space between the skin and the inner surface of the clothing was 10 mm or less. The long-sleeved shirt of Example 2 was a compression-type shirt.

(Comparative Example 1)

[0065] A long-sleeved shirt having the same shape as Example 1 was made by using only the heat dissipating fabric A.

(Comparative Example 2)

[0066] A long-sleeved shirt having the same shape as Example 2 was made by using only the heat dissipating fabric B.

(Evaluation)

[0067] Each of 10 healthy male subjects wore the shirt of Example 1 and the shirt of Comparative Example 1. The subjects rested for 30 minutes and then started to do push-ups when they heard a sound signal. Both the time it took before the individual subjects did a push-up in response to the sound signal (i.e., the time between the sound signal and the start of push-up motion) and the time it took for them to do one push-up were measured. The average of the times spent before starting the push-up motion and the average of the times required for one push-up were obtained. Further, the average values of Example 1 were compared to those of Comparative Example 1. The results are as follows.

Time spent before starting push-up: Example 1 < Comparative Example 1

Time required for one push-up: Example 1 < Comparative Example 1

[0068] Since the shirt of Example 1 used the heat retaining fabric, the muscle temperature was increased to improve the reaction and the power output of the muscles. Therefore, it was confirmed that the shirt of Example 1 helped to reduce both the time spent before starting the push-up motion and the time required for one push-up.

[0069] Next, the thermal comfort of the body was evaluated after the individual subjects did 50 push-ups at a rate of one per second. The results are as follows.

Example 1: slightly warm

Comparative Example 1: slightly warm

[0070] The shirt of Example 1 was able to efficiently cool the blood vessels due to the presence of the heat dissipating fabric, and thus achieved the thermal comfort substantially comparable to the shirt of Comparative Example 1.

[0071] Next, each of 10 healthy male subjects wore the shirt of Example 2 and the shirt of Comparative Example 2. The subjects rested for 30 minutes and then started to do push-ups when they heard a sound signal. Both the time it took before the individual subjects did a push-up in response to the sound signal (i.e., the time between the sound signal and the start of push-up motion) and the time it took for them to do one push-up were measured. The average of the times spent before starting the push-up motion and the average of the times required for one push-up were obtained. Further, the average values of Example 2 were compared to those of Comparative Example 2. The results are as follows.

Time spent before starting push-up: Example 2 < Comparative Example 2

Time required for one push-up: Example 2 < Comparative Example 2

[0072] Since the shirt of Example 2 used the heat retaining fabric, the muscle temperature was increased to improve the reaction and the power output of the muscles. Therefore, it was confirmed that the shirt of Example 2 helped to reduce both the time spent before starting the push-up motion and the time required for one push-up.

[0073] Next, the thermal comfort of the body was evaluated after the individual subjects did 50 push-ups at a rate of one per second. The results are as follows.

Example 2: slightly warm

Comparative Example 2: slightly warm

[0074] The shirt of Example 2 was able to efficiently cool the blood vessels due to the presence of the heat dissipating fabric, and thus achieved the thermal comfort substantially comparable to the shirt of Comparative Example 2.

[0075] As is evident from the above evaluation, the shirts of Examples 1, 2 can warm the agonist muscles during exercise to improve the power output of the muscles and to promote supercompensation, and at the same time they can dissipate heat from the heat dissipation

areas of the body to reduce an increase in the core temperature. Consequently, the shirts of Examples 1, 2 allow the wearer to continue exercise without reducing the thermal comfort. Moreover, the shirts serve to shorten the warm-up time and also enable the body to prepare for taking part in a sport.

Industrial Applicability

[0076] The shirt of the present invention is applicable to various types of shirts, including sleeveless shirts, short-sleeved shirts, three-quarter sleeve shirts, and long-sleeved shirts. Moreover, the shirt of the present invention is suitable for sports shits such as baseball, soccer, rugby, marathons, running, walking, cycling, mountain climbing, and tennis. In particular, the shirt of the present invention is preferably used as a warm-up shirt for sports.

Description of Reference Numerals

[0077]

1, 11 Long-sleeved shirt
2, 19, 28 Heat retaining fabric arranged to cover pectoralis major muscle
3a, 3b, 20a, 20b, 29a, 29b Heat retaining fabric arranged to cover deltoid muscle, biceps brachii muscle, and triceps brachii muscle
4, 21, 30 Heat dissipating fabric arranged to cover abdomen
5a, 5b, 22a, 22b, 31a, 31b Heat dissipating fabric arranged to cover axillary region
6a, 6b, 23a, 23b, 32a, 32b Heat dissipating fabric arranged to cover lateral region
7a, 7b Heat dissipating fabric arranged to cover forearm
8a, 8b, 24a, 24b, 33a, 33b Heat dissipating fabric arranged to extend from shoulder to axillary region
9, 25, 34 Heat retaining fabric arranged in upper portion of back of shirt
10, 26, 35 Heat dissipating fabric arranged in lower portion of back of shirt
12a, 12b Heat retaining fabric arranged to cover pectoralis major muscle
13a, 13b Heat retaining fabric arranged to cover deltoid muscle
14a, 14b Heat retaining fabric arranged to cover biceps brachii muscle
15 Heat dissipating fabric making up entire shirt
16 Heat retaining fabric arranged in upper portion of back of shirt
17a, 17b Heat retaining fabric arranged to cover triceps brachii muscle
18 Short-sleeved shirt
27 Sleeveless shirt

[0078] The invention may be embodied in other forms without departing from the spirit or essential characteristics thereof. The embodiments disclosed in this application are to be considered in all respects as illustrative and not limiting. The scope of the invention is indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Claims

1. A shirt comprising a heat retaining fabric and a heat dissipating fabric,

   wherein the heat retaining fabric (2, 9, 3a, 3b) is configured to be arranged in a portion of a front of the shirt that covers at least a part of the pectoralis major muscle, in an upper portion of a back of the shirt, and in portions of the shirt, each of which covers at least a part of the upper arm, when the shirt is worn,
   the heat dissipating fabric (8a, 8b, 5a, 5b) is configured to be arranged in portions of the back of the shirt, each of which extends from the shoulder, passes through the side of the dorsum, covers at least a part of the infraspinatus muscle, and is connected to the axillary region, when the shirt is worn, and
   the heat retaining fabric (9) arranged in the upper portion of the back of the shirt is separated from the heat retaining fabric (3a, 3b) arranged in the portions of the shirt, each covering at least a part of the upper arm, by the heat dissipating fabric (8a, 8b, 5a, 5b) arranged in the portions of the back of the shirt, each extending from the shoulder, passing through the side of the dorsum, covering at least a part of the infraspinatus muscle, and being connected to the axillary region.

2. The shirt according to claim 1, wherein the heat retaining fabric (2) arranged in the portion of the front of the shirt, covering at least a part of the pectoralis major muscle, covers most of the pectoralis major muscle and is connected to the heat retaining fabric (3a, 3b) arranged in the portions of the shirt, each covering at least a part of the upper arm.

3. The shirt according to claim 1 or 2, wherein the heat retaining fabric (13a, 13b) is configured to be further arranged in portions of the shirt, each of which covers at least a part of the deltoid muscle, when the shirt is worn.

4. The shirt according to any one of claims 1 to 3, wherein the heat retaining fabric (14a, 14b) is configured to be further arranged in portions of the shirt, each

of which covers at least a part of the biceps brachii muscle, and the heat retaining fabric (17a, 17b) is configured to be further arranged in portions of the shirt, each of which covers at least a part of the triceps brachii muscle, when the shirt is worn.

5. The shirt according to any one of claims 1 to 4, wherein the heat dissipating fabric (4) is configured to be arranged in a portion of the front of the shirt that covers the abdomen, when the shirt is worn.

6. The shirt according to any one of claims 1 to 5, wherein the heat dissipating fabric (10) is configured to be arranged in a lower portion of the back of the shirt, when the shirt is worn.

7. The shirt according to any one of claims 1 to 6, wherein the heat retaining fabric is at least one fabric selected from the group consisting of a moisture-absorbent heat-generating fabric, a fabric containing fibers with low thermal conductivity, a fabric containing heat storage fibers, a fluffy fabric, a point-contact fabric, a vapor-deposited fabric having a radiation effect, and a fabric with low breathability.

8. The shirt according to any one of claims 1 to 7, wherein the heat dissipating fabric is at least one fabric selected from the group consisting of a fabric containing quick-drying fibers, a fabric containing fibers with high thermal conductivity, a thin fabric, a fabric with high breathability, and a fabric containing cooling fibers.

9. The shirt according to any one of claims 1 to 8, wherein the heat retaining fabric is a moisture-absorbent heat-generating fabric containing highly crosslinked polyacrylate fibers and the heat dissipating fabric is a water-absorbent quick-drying polyester fabric.

10. The shirt according to any one of claims 1 to 9, wherein the shirt is a compression-type shirt.

11. The shirt according to any one of claims 1 to 10, wherein the shirt is a sports shirt.

12. Use of the shirt according to any one of claims 1 to 11.

13. Use of the shirt according to claim 12, wherein the shirt is a sleeveless shirt, a short-sleeved shirt, a three-quarter sleeve shirt, or a long-sleeved shirt.

14. Use of the shirt according to claim 12 or 13, wherein the shirt is a warm-up shirt for sports.

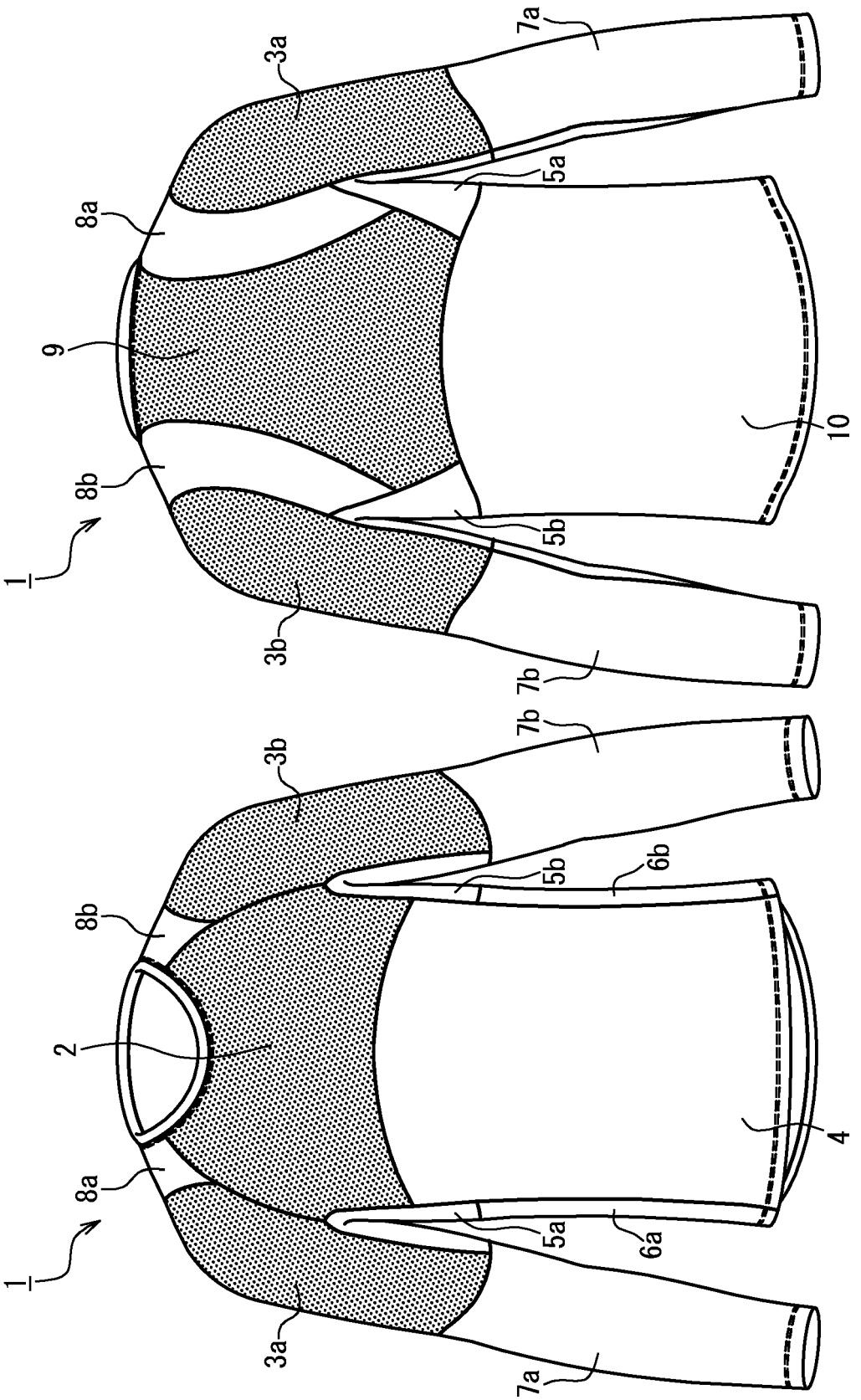


FIG. 1A

FIG. 1B

FIG. 2A

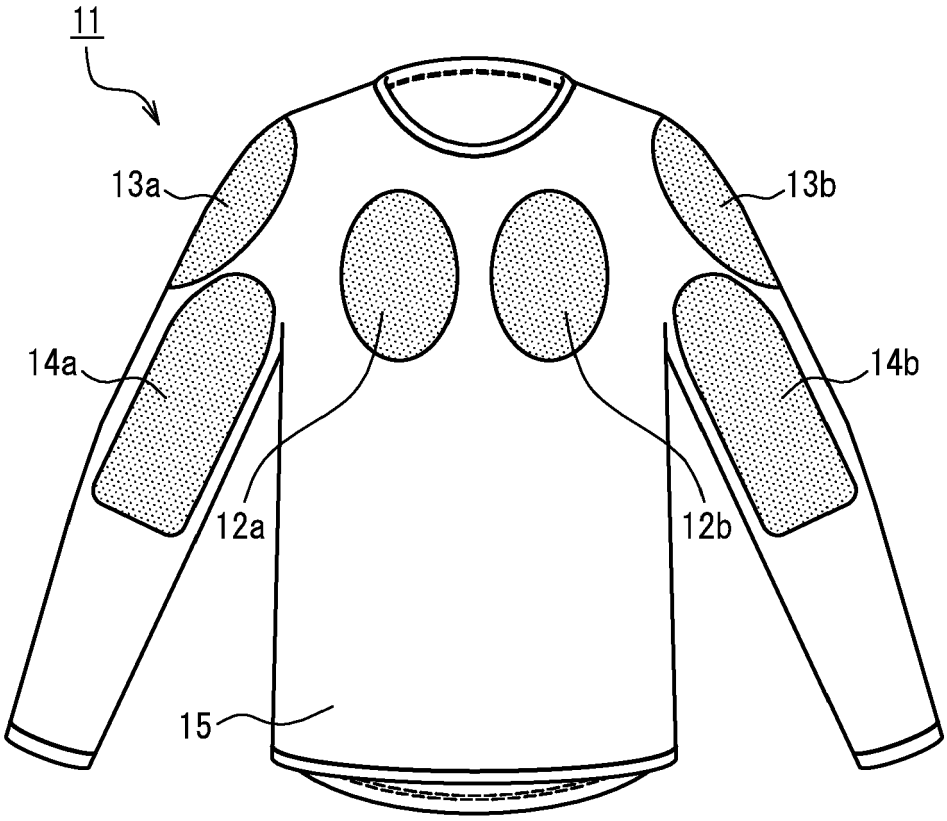
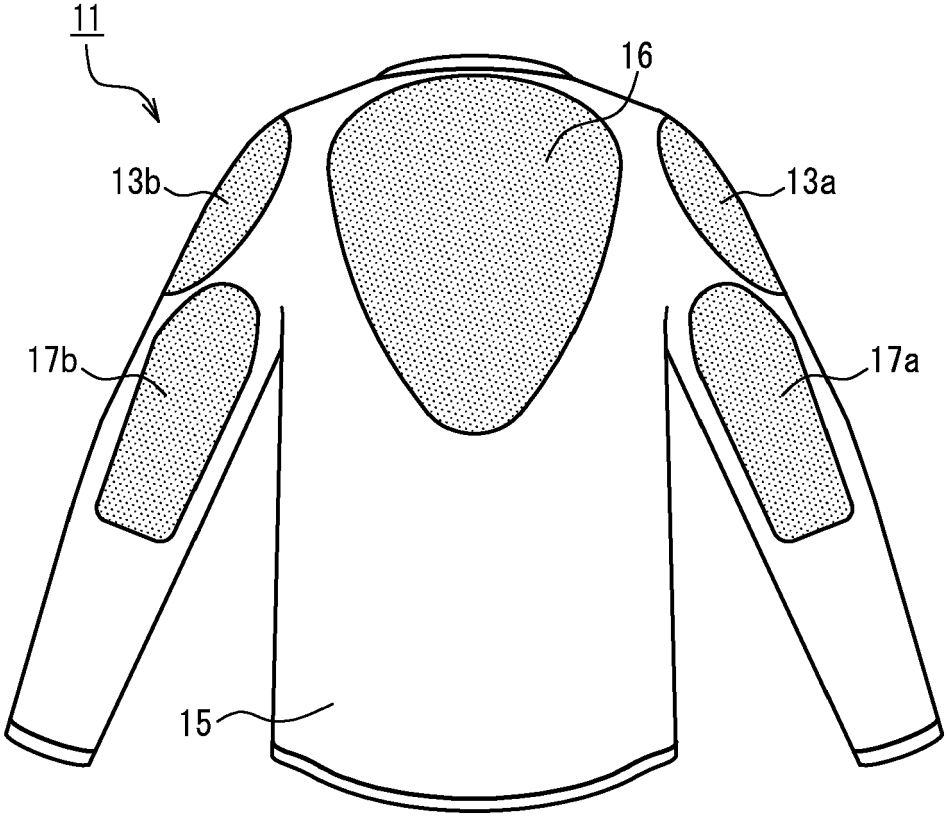


FIG. 2B



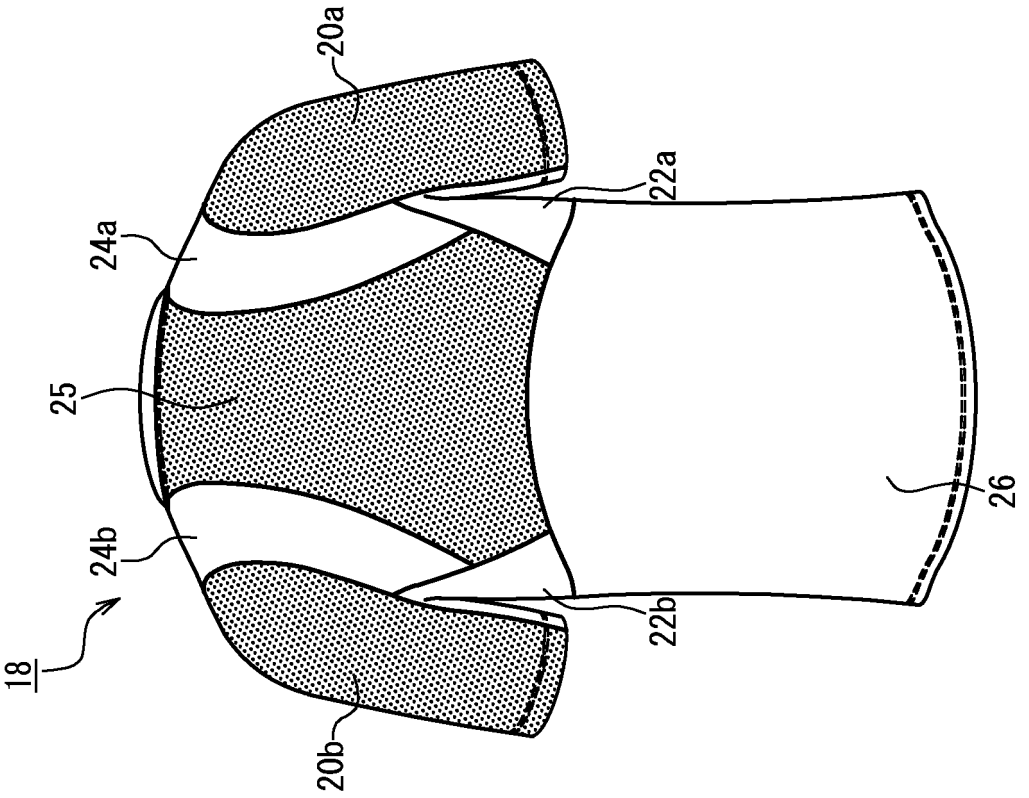

20a
22a
24a
25
24b
18
22b
20b
26

FIG. 3B

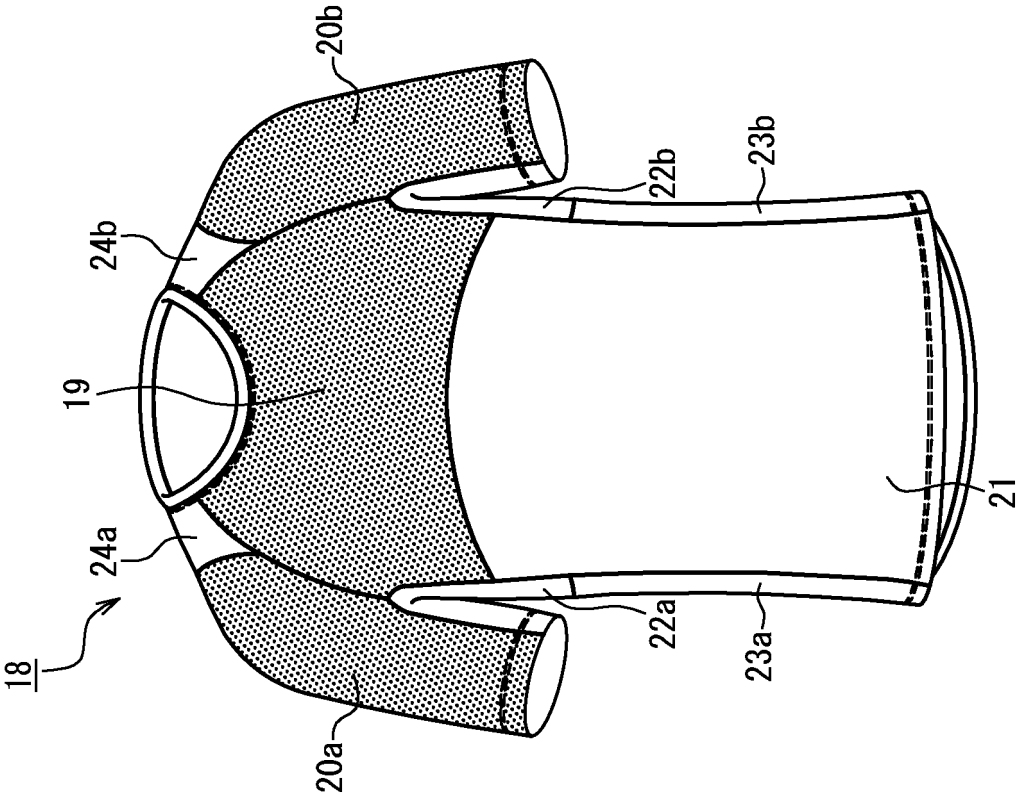

20b
22b
23b
24b
19
24a
18
22a
23a
20a
21

FIG. 3A

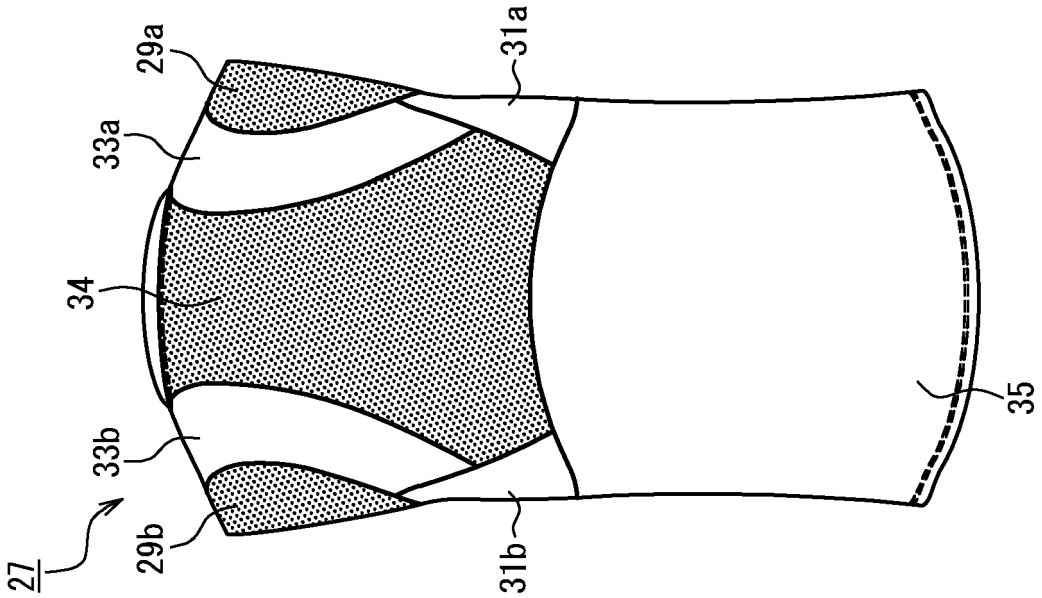

29a
33a
34
33b
27
29b
31a
31b
35

FIG. 4B

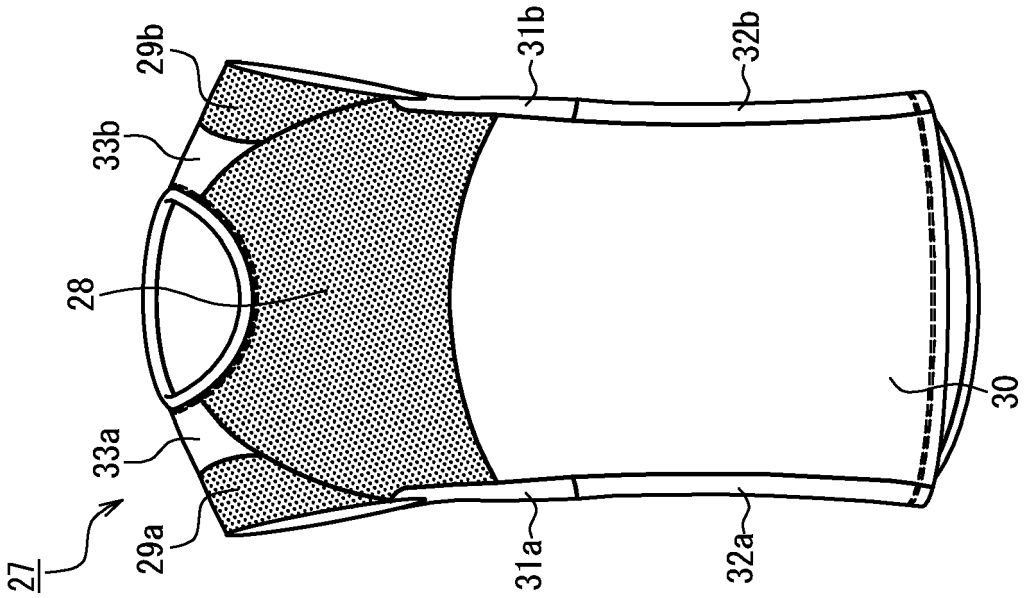

29b
33b
28
33a
27
29a
31b
32b
31a
32a
30

FIG. 4A

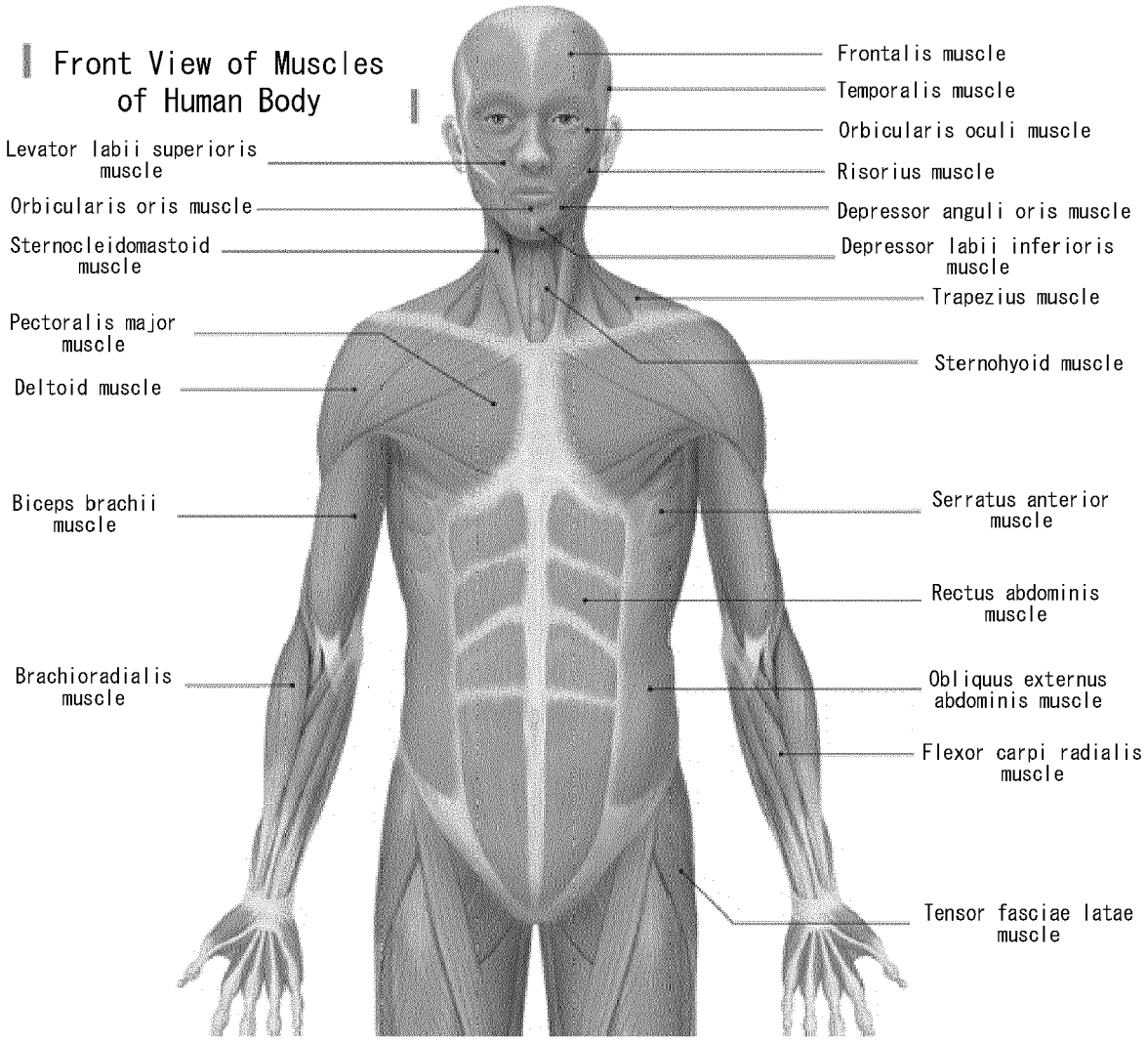

Front View of Muscles of Human Body
Levator labii superioris muscle
Orbicularis oris muscle
Sternocleidomastoid muscle
Pectoralis major muscle
Deltoid muscle
Biceps brachii muscle
Brachioradialis muscle
Frontalis muscle
Temporalis muscle
Orbicularis oculi muscle
Risorius muscle
Depressor anguli oris muscle
Depressor labii inferioris muscle
Trapezius muscle
Sternohyoid muscle
Serratus anterior muscle
Rectus abdominis muscle
Obliquus externus abdominis muscle
Flexor carpi radialis muscle
Tensor fasciae latae muscle

FIG. 5

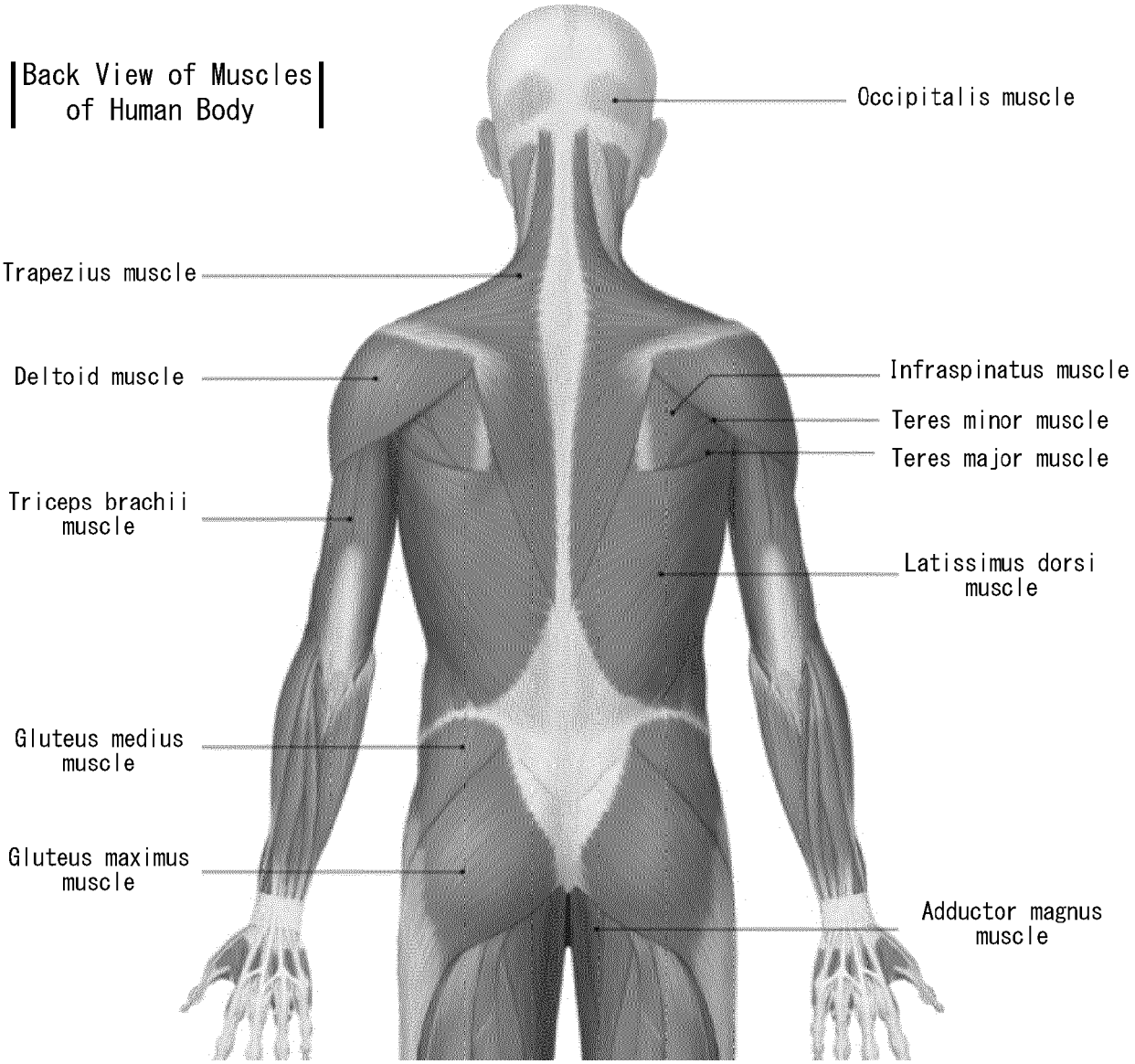

Back View of Muscles of Human Body
Occipitalis muscle
Trapezius muscle
Deltoid muscle
Infraspinatus muscle
Teres minor muscle
Teres major muscle
Triceps brachii muscle
Latissimus dorsi muscle
Gluteus medius muscle
Gluteus maximus muscle
Adductor magnus muscle

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 22 15 5073

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	* abstract * * page 9, line 33 - page 10, line 30 * * page 12, line 26 - page 13, line 2 * * page 22, line 30 - page 23, line 7 * * page 23, line 18 - page 24, line 2 * * figures 10A, 10B, 16-19 *	2,9	ADD. A41D13/00 A41D27/28 A41D31/06 A41D31/12
X	EP 3 560 366 A1 (SALOMON SAS [FR]) 30 October 2019 (2019-10-30)	1,3,5-7, 10-14	
A	* abstract * * paragraphs [0001] - [0003], [0009], [0013], [0017] - [0027], [0032] - [0034] * * figures 5, 6, 10, 11 *	2,4,8,9	

TECHNICAL FIELDS SEARCHED (IPC)

A41D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 July 2022	Dogantan, Umut H.

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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26-07-2022

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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