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(71) Applicant: **SWANEE CO LTD**
8-25 Shimoshinjo 5-chome,
Higashiyodogawa-ku
Osaka City, Osaka 533(JP)

(72) Inventor: **Magata, Katsumi, c/o Swanee Co**
Ltd.
8-25 Shimoshinjo 5-chome,
Higashiyodogawa-ku
Osaka City, Osaka 533(JP)

(74) Representative: **Copp, David Christopher et al**
Dummett Copp & Co.
25 The Square
Martlesham Heath
Ipswich Suffolk IP5 7SL (GB)

(54) **Underwear comprising fiber containing metal.**

(57) This invention relates to underwear comprising the fiber containing metal, which comprises fiber materials mixed-spun with 2-50% polyurethane elastic fiber to which at least one of metal oxides selected from alumina, silica, and titania, as well as platinum are mixed as essential components, where in, because metal oxides are mixed in the polyurethane elastic fiber with expandability, electromagnetic radiation (far infrared radiation) liberated from the metal oxides are emitted nearly in close contact with the human body, permitting electromagnetic radiation (far infrared radiation) to work effectively on the contact feeling at the wearing portion as well as when the underwear is put on and thermal conductivity while it is worn, and enabling manifestation of an extremely excellent heat-retaining effect.

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Field of the Invention

This invention relates to underwear comprising fiber containing metal and the object of the present invention is to provide underwear comprising fiber containing metal which not only provides flexibility and excellent smooth touch when it is put on and agreeable wear comfort while it is worn but also manifests an extremely good heat-retaining effect that the underwear provides unnoticeable contact feeling when it is put on and small thermal conductivity while it is worn and the blood flow rate tends to rise at the wearing portion.

Description of Prior Art

In general, for fiber materials forming men's underwear such as long-sleeved shirts, shirts with half-length sleeves, and drawers, and ladies' tee shirts, semi-long-sleeved shirts and panties, cotton, nylon, polyester, acrylic, and urethane fiber are popularly used, and these fiber materials are properly selected according to wearing seasons and mixed-spun at an optional ratio to form underwear.

For example, underwear for summer is formed with fiber materials primarily comprising cotton in view of permeability and absorbency, while underwear for winter, in addition to said fiber materials, wool is frequently mixed-spun to improve heat-retaining property.

Recently, in anticipation of heat-retaining property of far infrared radiation, there exists underwear using fiber mixed with far infrared irradiating ceramics as a component material.

This underwear uses fiber having far infrared irradiating materials like alumina, zirconia, or magnesia, contained in polyethylene- and polyamide-based fiber materials which show high permeability to far infrared radiation and the fiber materials containing this far infrared irradiating materials further covered with a protection layer, as part of the component fiber, and are formed in anticipation of the heat-retaining effect by wearing.

Problems to be Solved by this Invention

However, it is difficult that the underwear mixed-spun with the wool manifests sufficient heat-retaining effect unless wool is mixed-spun at high ratio, but mixed-spinning wool at high ratio to increase a heat-retaining effect causes bulkiness of the underwear itself, generating unfitting feeling for underwear which is put directly on the skin as underclothes for blouses and others; this not only prevents wear comfort but also restricts movement of the wearer, producing a problem that the underwear can not be worn readily.

On the other hand, the underwear mixed with far infrared irradiating ceramics can eliminate the bulkiness as compared with said underwear mixed-spun with wool but it has a problem that the intended effect is difficult to be achieved unless a large area is covered with the fiber material containing far infrared irradiating substance.

In addition, it has another problem that since in this underwear a covered layer is provided to protect the far infrared irradiating layer but this covered layer absorbs far infrared radiation, the far infrared radiation emitted from the ceramics is unable to be effectively used.

Consequently, this underwear has a problem that effect by the far infrared radiation is unable to work most effectively on the contact feeling when the underwear is put on, thermal conductivity while it is worn, and skin temperature after it is worn, so that the excellent heat-retaining effect cannot be expected.

Therefore, in the industry, invention of underwear which provides superb wear comfort to wearers, effects successfully on contact feeling when it is put on, thermal conductivity while it is worn, and the wearing portion, and manifests an extremely excellent heat-retaining property has been required.

Means to Solve the Problems

All of the above-mentioned prior problems are solved by providing underwear comprising fiber containing metal which is characterized in comprising fiber materials mixed-spun with polyurethane elastic fiber in the range of 2-50%, to which at least one of metal oxides selected from alumina, silica, and titania as well as platinum are mixed as essential components.

Detailed Description of the Invention

The construction of underwear comprising fiber containing metal relating to the present invention will be described in detail hereinafter.

In this invention, the fiber material mixed-spun with 2-50% polyurethane elastic fiber mixed with at least one of metal oxides selected from alumina (Al_2O_3), silica (SiO_2), and titania (TiO_2) as well as platinum (Pt) as essential components is designated as component fiber.

As alumina (Al_2O_3), silica (SiO_2), and titania (TiO_2) used in the present invention, those in the powder form with grain size of $1\ \mu$ or smaller are favorably used, but there is no restriction.

As platinum (Pt), that with grain size as fine as $7\text{-}40\text{\AA}$ and in a colloidal form is preferably used.

This is based on the experimental knowledge of the inventor that the use of colloidal-form platinum can yield the satisfactory heat-retaining property.

The mix ratio of these metal oxides and platinum is about 9-45% alumina (Al_2O_3), 50-80% silica (SiO_2), 8-15% each titania (TiO_2) and/or platinum (Pt), but there is no restriction.

To these metal oxides, oxides of calcium, zinc, and copper may be mixed by about 2-10%.

From the metal oxides comprised as above, electromagnetic radiation (far infrared radiation) with a 5-12 micron wavelength range to be effective for human bodies are stably and sufficiently emitted even at the temperature range of around 30°C , as clear from the following tests.

Polyurethane elastic fiber to which metal oxides and platinum are mixed is not particularly specified but SPANDEX which comprises a noncrystalline segments including either polyester or polyether portions and crystalline segment with urethane bonds and is popularly used in regular textile products is favorably used.

A method to mix metal oxides and platinum to said polyurethane elastic fiber is not particularly specified but any of the optional methods can be adopted as required, such as the method to mix the polymerized fiber material solution dispersedly in the solution before dry spinning or mix into the dry-spun yarns.

The blending ratio of metal oxides mixed in polyurethane elastic fiber is not particularly specified but any of the blending ratio can be favorably adopted if it is the blending ratio which emits electromagnetic radiation (far infrared radiation) with a wavelength range of about 5-12 microns to be effective for human bodies at the temperature around 30°C , successfully effects contact feeling and thermal conductivity during wearing and manifests satisfactory heat-retaining effect and is within the range that enables to spin and that does not impair wear comfort as a component fiber material of underwear.

Furthermore, in the present invention, the reason why polyurethane elastic fiber is particularly used is that mixed-spinning polyurethane elastic fiber with generous expandability results in improved wear comfort of underwear and at the same time mixing the above-mentioned metal oxides and platinum to this polyurethane elastic fiber enables emission of electromagnetic radiation (far infrared radiation) from the metal oxides into the body with the underwear closely in contact with the body of the wearer, makes the best use of the effect of emitted electromagnetic radiation (far infrared radiation), and allows the electromagnetic radiation (far infrared radiation) to work effectively on the contact feeling when the underwear is put on and the thermal conductivity, thereby temperature variation in the body increases after the underwear is worn, and the blood flow rate at the wearing portion is easy to increase, as a result, a superior heat-retaining effect can be manifested.

The polyurethane elastic fiber mixed with at least one of metal oxides selected from the above-mentioned alumina (Al_2O_3), silica (SiO_2), and titania (TiO_2) as well as platinum (Pt) as essential components is mixed-spun with other regular fiber materials into underwear through a regular method. In this event, polyurethane elastic fiber must be mixed-spun with metal oxides in the range of 2-50%.

This is because in case that the mixed-spinning ratio of polyurethane elastic fiber containing metal oxides is less than 2%, emission of electromagnetic radiation from metal oxides using the expandability of the above-mentioned polyurethane elastic fiber does not take place effectively and the superior heat-retaining property is not manifested, while in case that it is mixed-spun exceeding 50%, disagreeable touch is provided for the wearer and certain people may develop allergic symptoms, indicating that either of the cases is not desirable.

As other fiber materials to be mixed-spun with polyurethane elastic fiber, ordinary natural and artificial fiber materials such as cotton, hemp, wool, acrylic, polyester, and nylon are favorably used and these fiber materials may be optimally mixed-spun to make underwear at an optional ratio, and are not particularly specified.

In particular, underwear made by mixed-spinning cotton fiber in such a manner that the cotton fiber is located on the side in contact with the human body is favorably worn in the wintertime due to heat-retaining property of the cotton fiber.

Or, underwear made by mixed-spinning the cotton fiber in such a manner that this cotton fiber is located opposite the side in contact with the human body is favorably worn in the summertime due to the heat dissipation property of the cotton fiber.

Regular men's underwear such as undershirts, athletic shirts, briefs, shorts, and drawers and regular ladies' underwear such as panties, tanks, panty hoses, semi-long sleeve and tee shirts are given as examples of underwear included in the present invention, but not limited to.

5 Effects of the Invention

As described above in detail, because the present invention relates to the underwear comprising the fiber containing metal, which is characterized in comprising fiber material mixed-spun with more than 2-50% polyurethane elastic fiber, to which at least one of metal oxides selected from alumina, silica, and titania as well as platinum are mixed as essential components, bulkiness of the underwear itself hardly exists and agreeable wear comfort such as flexibility and expandability is ensured when the underwear is put on, and at the same time because electromagnetic radiation (far infrared radiation) by metal oxides is emitted nearly in close contact with the wearer by making use of expandability of polyurethane elastic fiber, as clear from the results of said tests, electromagnetic radiation (far infrared radiation) is permitted to work effectively on contact feeling of the wearing portion as well as when the underwear is put on and thermal conductivity while it is worn, enabling manifestation of an extremely excellent heat-retaining effect.

Brief Description of the Drawings

Figure 1 is a spectral emissivity chart for the fiber obtained in Example 2.
Figure 2 is a spectral emissivity chart for the fiber obtained in Example 3.
Figure 3 is a spectral emissivity chart for the fiber obtained in Example 4.
Figure 4 is a spectral emissivity chart for the fiber obtained in Example 5.
Figure 5 is a spectral emissivity chart for the fiber obtained in Example 6.

Examples

The effects of underwear comprising fiber containing metal relating to the present invention will become more apparent from the following examples.

(Example 1)

The 15% polyurethane elastic fiber mixed with metal oxides comprising alumina (Al_2O_3), silica (SiO_2), titania (TiO_2), and platinum (Pt) in the ratio 10:82:3:5 was mixed-spun with 85% cotton and made into ladies' tee shirts by an ordinary method.

(Comparison 1)

Ladies' tee shirts was made in the same manner of Example 1 except using polyurethane elastic fiber not mixed with metal oxides.

(Comparison 2)

The 1.7% polyurethane elastic fiber mixed with metal oxides comprising alumina (Al_2O_3), silica (SiO_2), titania (TiO_2), and platinum (Pt) in the ratio 10:82:3:5 was mixed-spun with 98.3% cotton and made into ladies' tee shirts by an ordinary method.

(Comparison 3)

Ladies' tee shirts was made in the same manner of Comparison 2 except using polyurethane elastic fiber not mixed with metal oxides.

(Test 1)

The ladies' underwear obtained in said Example 1 and Comparisons 1 through 3 were measured for various properties including density (g/m^2), thickness (cm), contact feeling (Q max), steady thermal conductivity ($\text{W/cm} \cdot ^\circ\text{C} \times 10^{-4}$), and heat-retaining ratio (%) with THERMOLABO 2-KES7 (KATOHEC: heat property measuring equipment).

Table 1 shows the results.

TABLE 1

	[A]	[B]	[C]	[D]	[E]
EXAMPLE 1	154	0.065	0.091	4.906	28.6
COMPARISON 1	149	0.068	0.102	3.855	25.3
COMPARISON 2	235	0.137	0.073	8.913	26.3
COMPARISON 3	233	0.140	0.078	9.020	26.9

[A] ... DENSITY (g/m²)

[B] ... THICKNESS (cm)

[C] ... CONTACT FEELING (Q max)

[D] ... STEADY THERMAL CONDUCTIVITY (W/cm°C × 10⁻⁴)

[E] ... HEAT-RETAINING RATIO (%)

※ 1

※ 2

※ 3

※ 1 : The coldness felt by wearer in putting on;

The bigger value indicates the more coldness.

※ 2 : The facility of thermal conduction of cloth;

The bigger value indicates the more facility.

※ 3 : The ability of heat-retaining of cloth;

The bigger value indicates the better ability.

(Test 2)

Using the ladies' underwear obtained in said Example 1 and Comparisons 1 through 3, tests were carried out on the living body.

First of all, for ladies' underwear of Example 1 and Comparison 1, skin temperature (minimum, average, maximum) of the back of the same paneler before and after putting on the underwear was measured.

The measurement was carried out on temperature retained by the underwear about 1200 seconds after it was put on and skin temperature of the back right after and about 66 seconds after the underwear was taken off.

The overall temperature variation in skin temperature at the back was calculated.

Next, using the same paneler, the measurement was carried out on the ladies' underwear of Comparisons 2 and 3 in the same manner.

The measured skin temperatures in this test were calculated from minimum, average, and maximum values of the picture analysis temperature distribution of a specific region of the thermogram obtained from thermo analysis by thermograph (NEC San-Ei 6T/62 type (HgCdTe sensor, 8-13 μ m): infrared radiation thermometer - 50- 2000 ° C).

Table 2 shows the results.

TABLE 2

	[A]	[B]	[C]	[D]
EXAMPLE 1	AVE. 34.25 MIN. 33.00 MAX. 35.13	34.63 (0.38) 33.50 (0.50) 35.63 (0.47)	34.38 33.25 35.38	0.13 ↑ 0.25 ↑ 0.25 ↑
COMPARISON 1	AVE. 34.13 MIN. 32.88 MAX. 35.13	33.88(-0.25) 32.50 (0.38) 35.00(-0.13)	33.63 32.25 34.75	-0.50 ↓ -0.63 ↓ -0.38 ↓
COMPARISON 2	AVE. 34.01 MIN. 32.88 MAX. 35.01	34.11 (0.10) 32.22 (0.01) 35.23 (0.22)	33.94 32.10 35.10	-0.07 ↓ -0.11 ↓ 0.09 ↑
COMPARISON 3	AVE. 34.52 MIN. 32.91 MAX. 35.21	34.70 (0.18) 32.85(-0.06) 35.51 (0.30)	34.55 32.84 35.30	0.03 ↑ -0.07 ↓ 0.09 ↑
[A] ... BEFORE PUTTING ON / HEAT-RETAINING FOR 1,200 SEC. [B] ... RIGHT AFTER TAKING OFF [C] ... RADIATION OF HEAT / RADIATION FOR 66 SEC. [D] ... OVERALL TEMPERATURE VARIATION THE UPPER ROW : AVERAGE TEMPARATURE (° C) THE MIDDLE ROW : MINIMUM TEMPARATURE (° C) THE LOWER ROW : MAXIMUM TEMPARATURE (° C) () indicates temparature of heat-retaining effect.				

(Test 3)

The ladies' underwear of said Example 1 and Comparison 1 were respectively worn by two panelers, and the blood flow rate (ml/min/100g) was measured by the laser Doppler method (Journal of the Laser Medical Society of Japan Vol. 12, No. 1, 7. 1988) using the laser Doppler rheometer (ADVANST: ALF-21) in case that the underwear was worn for a specified period.

Table 3 shows the results.

TABLE 3

	BLOOD FLOW OF FINGER (ml/min/100g)	
	PANELER A	PANELER B
EXAMPLE 1	30	31
	11:40~11:50	11:00~11:06
COMPARISON 1	22	14
	10:40~10:50	11:50~12:00
THE LOWER ROW ... TIME OF MEASURE		

As clear from TABLE 1, in case that mixed-spinning ratio of polyurethane elastic fiber is 15%, comparing ladies' underwear mixed with metal oxide (Example 1) with that not mixed with metal oxide (Comparison 1) shows that small contact feeling results in small coldness when it is put on and small steady thermal conductivity results in small temperature variation due to the coldness of open-air, proving a high heat-retaining ratio.

In case that polyurethane elastic fiber is mixed-spun as low as 1.7% (Comparison 2), the effect is similar to that using polyurethane elastic fiber not containing metal oxides (Comparison 3), showing that heat-retaining effect is not sufficiently manifested.

As clear from TABLE 2, in case of mixed-spinning ratio of polyurethane elastic fiber is 15%, in the balance of heat-retaining and heat-radiation after putting on the underwear, the ladies' underwear containing metal oxides (Example 1) provides overall temperature variation difference 0.6 °C higher on average than that of ladies' underwear not containing metal oxides (Comparison 1), showing higher heat-retaining effect.

On the contrary, in case that the mixed-spinning ratio of polyurethane elastic fiber is low (Comparisons 2 and 3), heat-retaining effect by wearing underwear is not manifested.

As clear from TABLE 3, the ladies' underwear of Example 1 tends to increase the blood flow rate by heat-retaining as compared with the ladies' underwear of Comparison 1.

(Example 2)

The 15% polyurethane elastic fiber containing metal oxides comprising alumina (Al_2O_3), silica (SiO_2), titania (TiO_2), and platinum (Pt) in the ratio 10:82:3:5 is mixed-spun with 85% cotton to make fiber.

(Example 3)

The 18% polyurethane elastic fiber same as said Example 2 are mixed-spun with 82% cotton to make fiber.

(Example 4)

The 28% polyurethane elastic fiber same as said Example 2 are mixed-spun with 72% cotton into fiber.

(Example 5)

The 50% polyurethane elastic fiber same as said Example 2 are mixed-spun with 50% staple fiber to make fiber.

(Example 6)

The 17% polyurethane elastic fiber same as said Example 2 are mixed-spun with 83% nylon to make fiber.

(Test 4)

For the fiber obtained by Examples 2 through 6, spectral emissivity was measured.

Measuring conditions are the wavelength range: 4.5-20.0 μm ; resolution: 16cm^{-1} ; detector: wide-range MCT; measuring temperature: 33 °C for surface temperature of texture; measuring position and time: four times in total, each once at two different positions and twice at the same position.

Figures 1 through 5 show the obtained relevant spectral emissivity.

As clear from the obtained spectral emissivity, in the fiber obtained in Examples 2 through 6, electromagnetic radiation (far infrared radiation) with wavelengths about 5-12 microns to be effective for human bodies are emitted even at the comparatively low temperature range of 33 °C.

Claims

1. Underwear comprising fiber containing metal which is characterized in comprising fiber materials mixed-spun with polyurethane elastic fiber in the range of 2-50%, to which platinum and at least one of metal oxides selected from alumina, silica, titania are mixed.

2. Underwear comprising the fiber containing metal according to Claim 1, which is characterized in that said cotton fiber is mixed-spun to the fiber materials and this cotton fiber is spun to be located to the side in contact with a human body.

3. Underwear comprising the fiber containing metal according to Claim 1, which is characterized in that said cotton fiber is mixed-spun to the fiber materials and this cotton fiber is spun to be located opposite the side in contact with a human body.

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Fig. 1

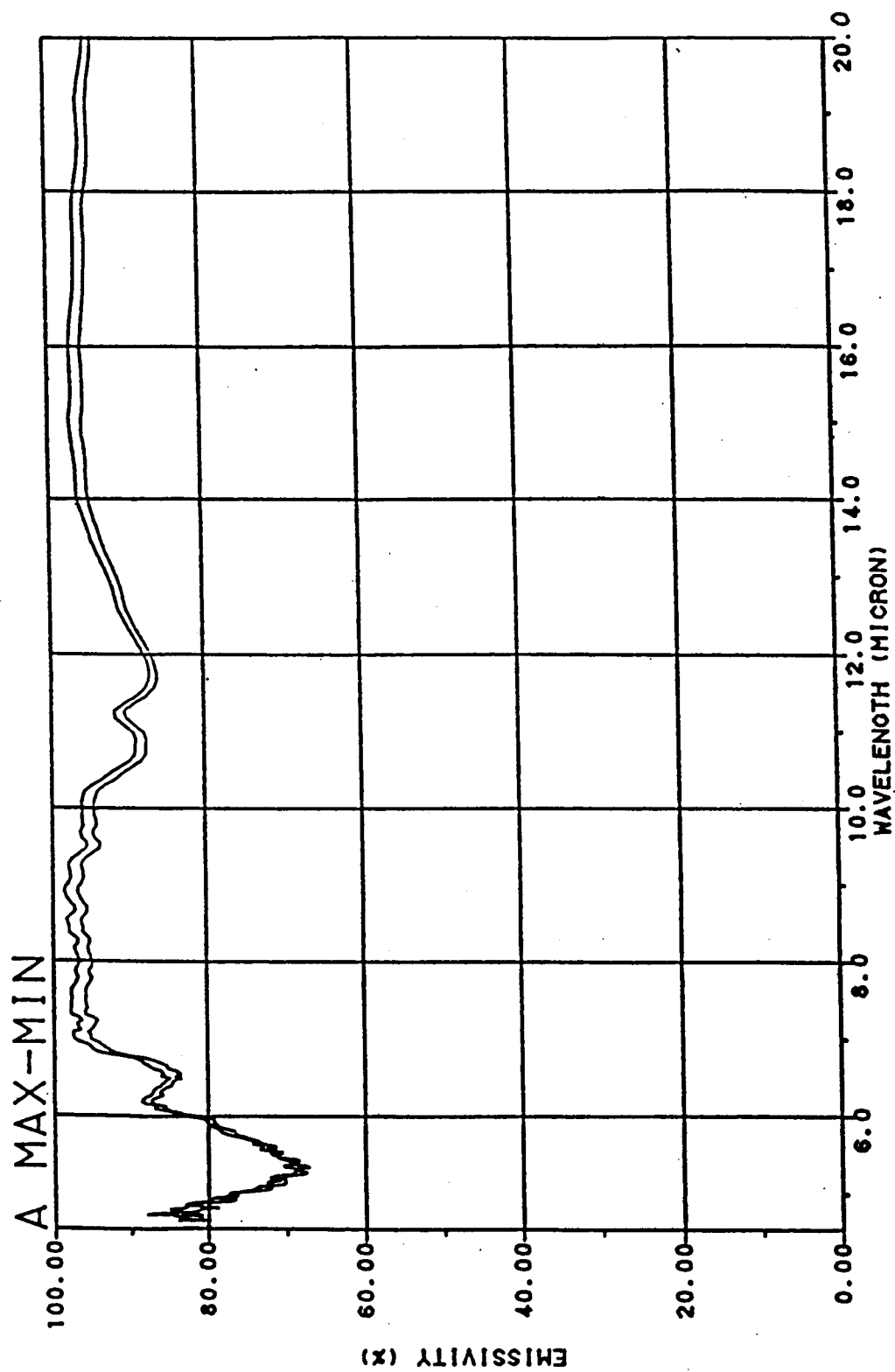


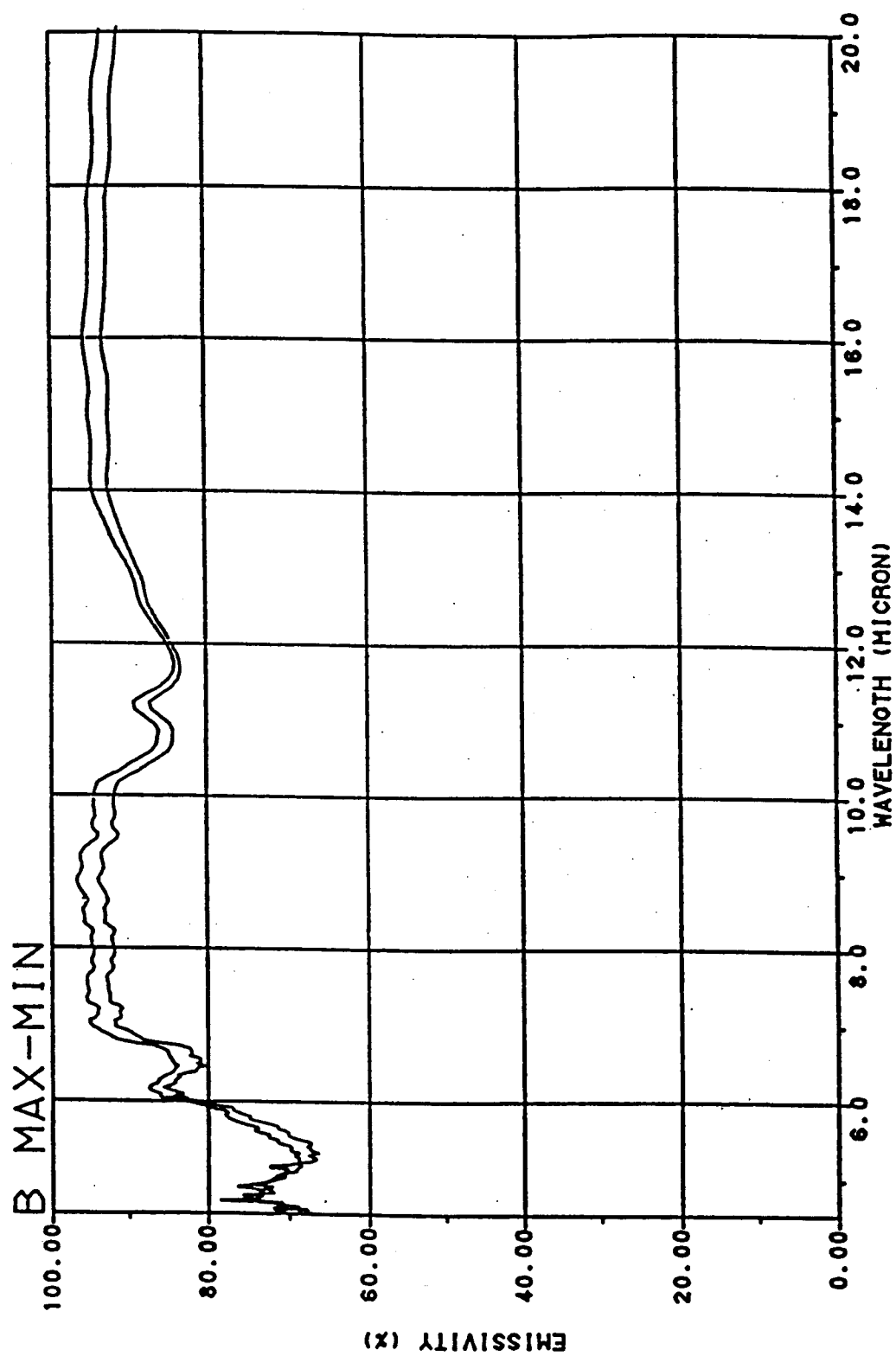
Fig. 2

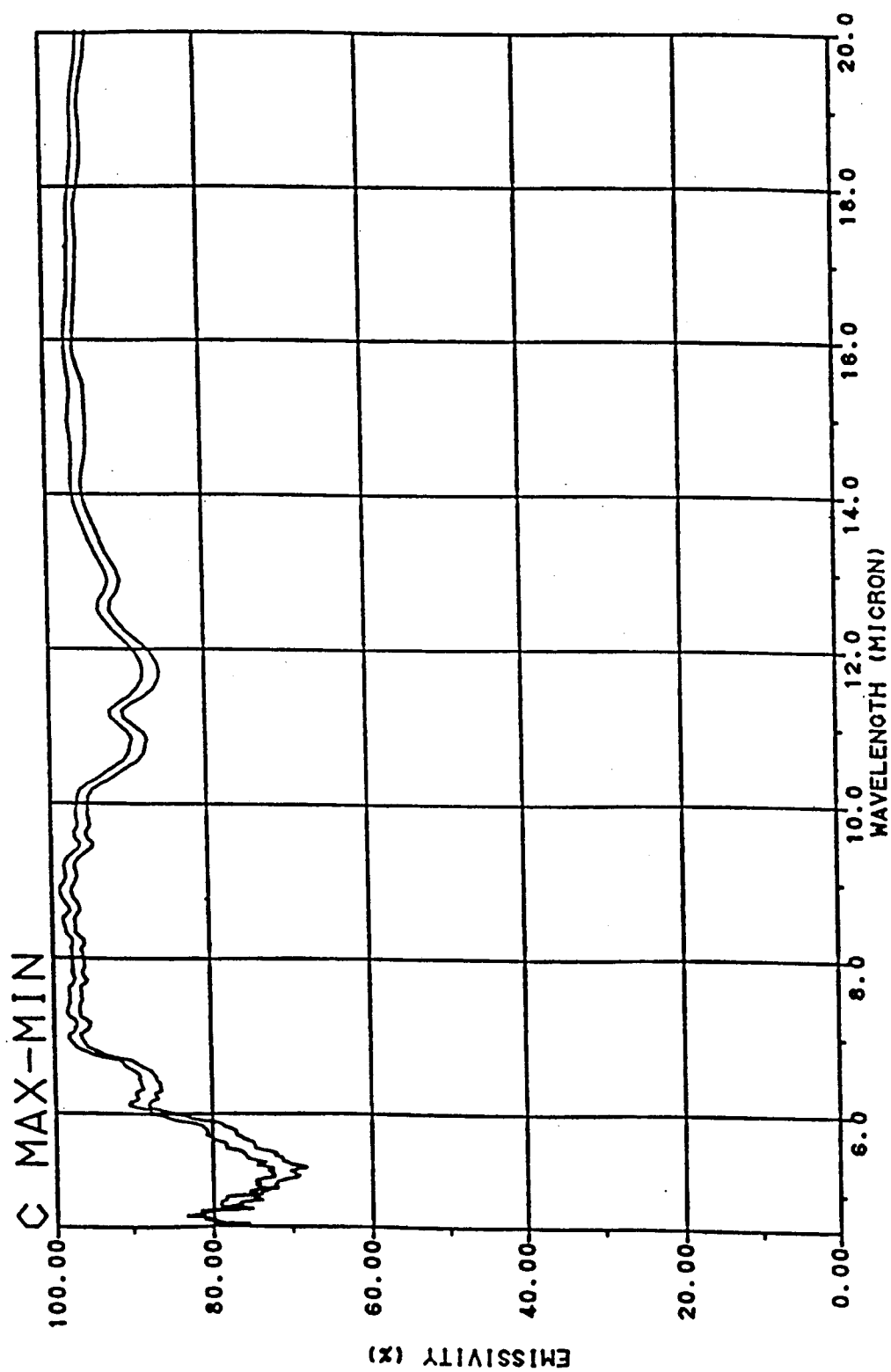
Fig. 3

Fig. 4

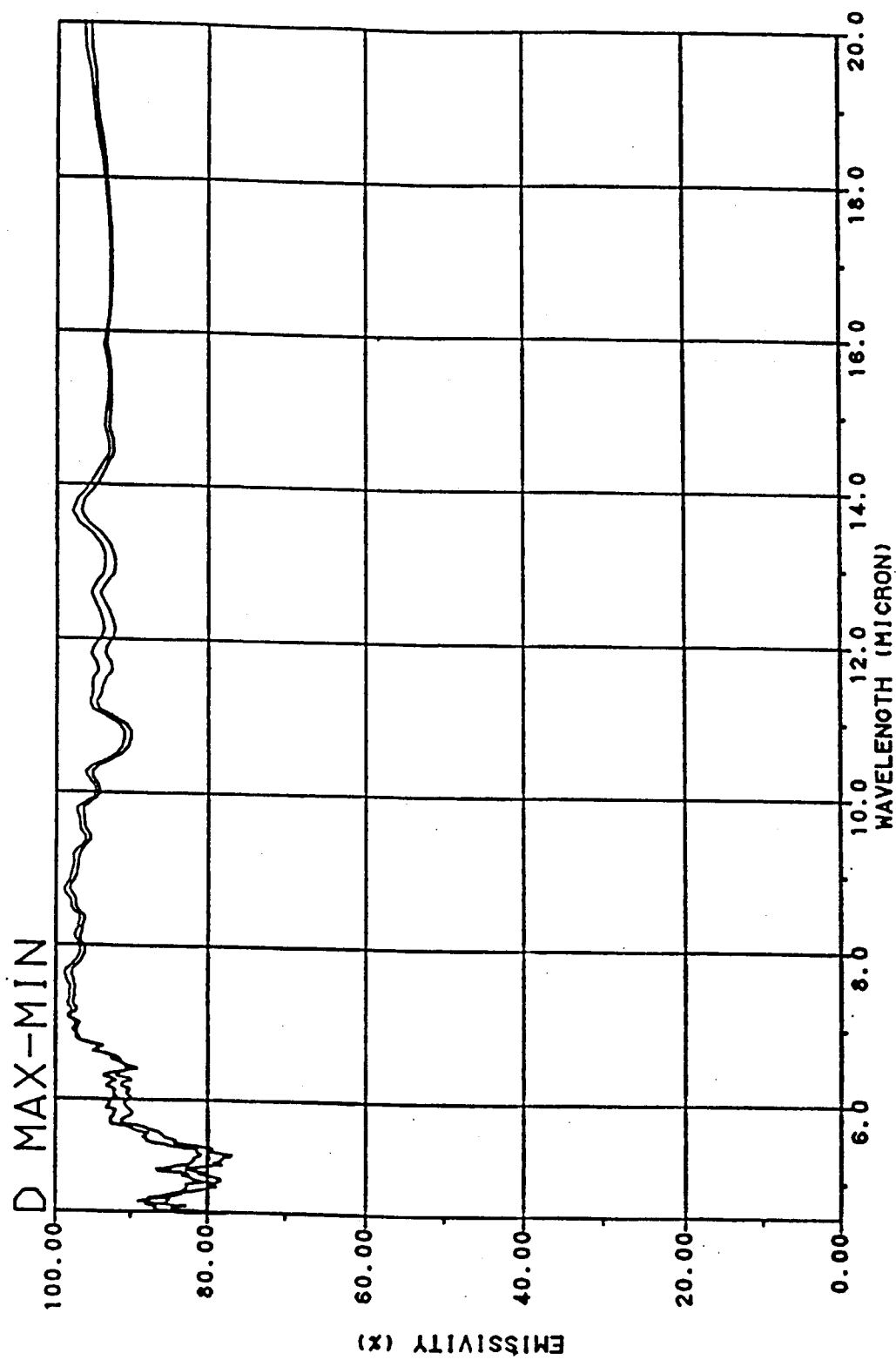
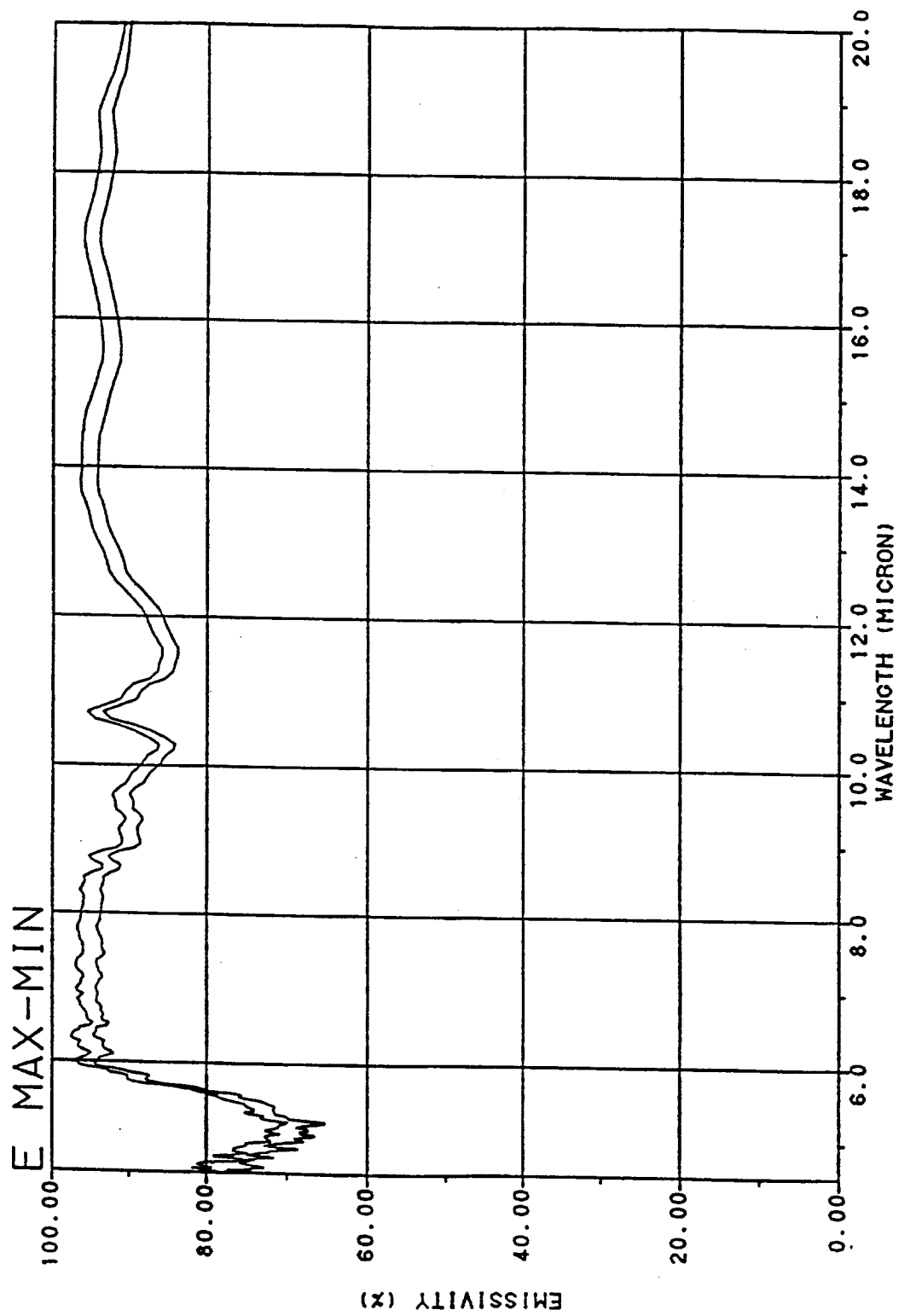


Fig. 5





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 93 10 1478

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	DATABASE WPI Week 9216, Derwent Publications Ltd., London, GB; AN 92-128857 & JP-A-4 073 226 (JPU KK) 9 March 1992 * abstract * ---	1	A41B17/00 A41B9/00
X	DATABASE WPI Week 9149, Derwent Publications Ltd., London, GB; AN 91-358561 & JP-A-3 241 025 (JPU KK) * abstract * ---	1	
E	DATABASE WPI Week 9320, Derwent Publications Ltd., London, GB; AN 93-165022 & JP-A-5 098 564 (MAEDA N) * abstract * ---	1	
A	DATABASE WPI Week 9241, Derwent Publications Ltd., London, GB; AN 92-336108 & JP-A-4 240 205 (KURARAY CO LTD) * abstract * ---	1	TECHNICAL FIELDS SEARCHED (Int.Cl.5) A41B A41D
A	FR-A-1 594 246 (L. WEISZ) * the whole document * -----	2,3	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 25 October 1993	Examiner GARNIER, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			