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(54) LOW BASIS WEIGHT TIPPING PAPER AND CIGARETTE WITH FILTER

(57) There is disclosed a tipping paper which includes pulp, and titanium oxide as a filler, wherein when x represents a basis weight (gsm) of the pulp and y represents a basis weight (gsm) of the titanium oxide, x and y satisfy the following formula:

$$31 \leq x + y < 35,$$

Where x and y are $27 \leq x < 31$ and $4 \leq y < 8$.

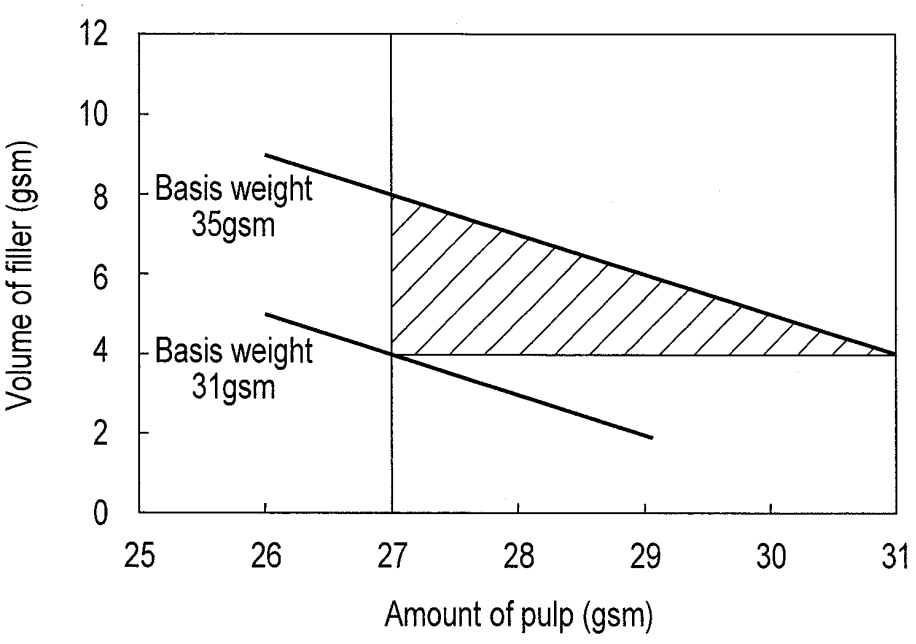

FIG. 3

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Description

Technical Field

[0001] The present invention relates to a tipping paper having a low basis weight which is rolled up as an outermost layer of a filter portion of a filter-equipped cigarette and a filter-equipped cigarette comprising the tipping paper.

Background Art

[0002] A filter-equipped cigarette is manufactured by facing a cigarette rod to a filter and rolling the whole outer periphery surface of the filter and the peripheral surface portion of the cigarette rod in the face vicinity with a tipping paper to unite the cigarette rod with the filter.

[0003] There is a need for the tipping paper to have functional characteristics such as tensile strength which is the required quality at the time of rolling, stiffness which is the required appearance quality of the rolled products at the time of rolling, hiding of the dust of powder, opacity to be required for design, and fire retardancy to guarantee proper burning in the vicinity of the filter, and to have a low basis weight from the viewpoint of production and reduction in weight at the time of transportation.

[0004] Incidentally, Japanese Patent No. 2875184 discloses the invention of a fire-retardant base paper which is used for a tipping paper containing titanium oxide and kaolin as a filler. However, the invention relates to the improvement of the filler and the base paper still has a general basis weight (37 gsm) as described in examples.

[0005] Jpn. Pat. Appln. KOKAI Publication No. 10-219599 discloses a tipping paper which contains calcium carbonate with a specific particle size and reduces the wear of a breaking instrument (blade, etc.) at the time of cutting. The claims in this patent publication describe that the basis weight of the tipping paper is 32 gsm. However, the invention of the patent publication aims at substituting titanium dioxide with an inexpensive one. As an alternative material thereof, calcium carbonate having a specific particle size is used. Accordingly, the fire retardancy to be required as the tipping paper is sacrificed.

[0006] Therefore, in the above Patent Literatures, there is neither description nor suggestion in terms of satisfying functional characteristics of the tipping paper, such as tensile strength, stiffness, opacity, and fire retardancy in the design of the tipping paper and achieving a low basis weight region.

[0007] On the other hand, it is true that the tipping base paper having a basis weight of 31 to 35 gsm is distributed to the market. Although the tipping base paper having a low basis weight guarantees the tensile strength by the blending of pulp and a beating degree, the paper is soft and lack of stiffness. Thus, the tipping base paper is inferior in rolling properties and quality of the rolled products when applying to the filter-equipped cigarette. Further, fire retardancy is also insufficient.

Disclosure of Invention

[0008] The present invention has been made in order to solve the above problems. The present invention provides a tipping paper in which functional characteristics of the tipping paper, such as tensile strength, stiffness, opacity, and fire retardancy are satisfied and the low basis weight is achieved; and a filter-equipped cigarette comprising the tipping paper.

[0009] According to a first embodiment of the present invention, there is provided a tipping paper comprising pulp, and titanium oxide as a filler, wherein when x represents a basis weight (gsm) of the pulp and y represents a basis weight (gsm) of the titanium oxide, x and y satisfy the following formula: $31 \leq x + y < 35$, where x and y are $27 \leq x < 31$ and $4 \leq y < 8$.

Brief Description of Drawings

[0010]

FIG. 1 is a view showing a relationship among the amount of pulp, tensile strength, and stiffness of a general-purpose base paper;

FIG. 2 is a view showing a relationship between the basis weight and the opacity when calcium carbonate or titanium oxide as a filler is added to a specific amount of pulp;

FIG. 3 is a view showing appropriate ranges of the amount of pulp and the amount of the filler (titanium oxide) in order to achieve the low basis weight of the tipping paper of the present invention; and

FIG. 4 is a perspective view showing a filter-equipped cigarette according to an embodiment of the present invention.

Best Mode for Carrying Out the Invention

[0011] Hereinafter, the tipping paper having a low basis weight and the filter-equipped cigarette according to the embodiment of the present invention will be described in detail.

[0012] The tipping paper having a low basis weight according to the embodiment comprises pulp, and titanium oxide as a filler. When x represents the basis weight (gsm) of the pulp and y represents the basis weight (gsm) of the titanium oxide, x and y satisfy the following formula: $31 \leq x + y < 35$. Where x and y are $27 \leq x < 31$ and $4 \leq y < 8$. That is, the tipping paper according to the embodiment comprises pulp and titanium oxide (filler), wherein the basis weight is 31 gsm or more and less than 35 gsm, and the basis weights of the pulp and the titanium oxide are 27 gsm or more and less than 31 gsm, and 4 gms or more and less than 8 gms, respectively.

[0013] Any pulps may be used as long as they are used for the normal tipping paper. Examples thereof include wood pulp classified into an L material (hardtwood) and an N material (softwood); nonwood pulp, such as bagasse, flax, and hemp; mechanical pulp obtained by simply crushing wood; and chemical pulp taken out by chemical treatment.

[0014] The average particle diameter of titanium oxide is preferably from 0.3 to 0.5 μm.

[0015] The present inventors have found that the tipping paper having a low basis weight based on the following findings.

(1) Problems in reduction in basis weight

[0016] When the basis weight of general-purpose tipping base paper having a basis weight of 37 gsm was simply decreased to 32 gsm without improving the composition, the tensile strength, stretch, stiffness, opacity, and whiteness which were functional characteristics were examined. The results are shown in Table 1 below. Note that the tensile strength, stretch, stiffness, opacity, and whiteness were measured by the measurement method in examples to be described later.

Table 1

Physical properties	Unit	Appropriate value	General-purpose product		Reduction in basis weight
Basis weight	gsm	-	37.0	⇒	32.0
Tensile strength	N/15 mm	26.0≤	31.6		22.3
Stretch	%	1.4≤	1.4		1.5
Stiffness	g/15 mm	2.0≤	3.3		1.9
Opacity	%	80.0≤	80.9		77.7
Whiteness	%	90.0≤	94.8		94.8

[0017] As is clear from Table 1 above, a large reduction in tensile strength is observed in the tipping base paper whose basis weight is simply decreased to 32 gsm. In addition, the deterioration of stiffness and opaque quality occurs. Thus, the simple reduction in basis weight cannot be applied to the tipping base paper. Therefore, in the design of low basis weight, a high-level design study is necessary to guarantee the tensile strength, stiffness, and opacity.

(2) Guarantee of tensile strength and stiffness

[0018] The composition of general-purpose tipping base paper was experimentally changed and a relationship between the tensile strength and stiffness was examined. The results are shown in FIG. 1. From FIG. 1, it was found that the minimum amount of pulp to be added to the tipping base paper was necessary to guarantee sufficient strength properties. The amount of pulp to guarantee the stiffness was 25 gsm or more. The amount of pulp to guarantee the tensile strength was 27 gsm or more. Therefore, it was found that the necessary amount of pulp was 27 gsm or more to satisfy strength properties. In other words, it was found that the lower limit of the basis weight was 27 gsm to maintain appropriate strength properties as the tipping base paper.

[0019] On the other hand, when the amount of pulp does not reach 27 gsm like the general-purpose tipping base paper, a method of improving the beating degree to increase the fiber density or a method of using an N material with strong fiber strength is used. However, such tipping base paper clearly leads a reduction in stiffness like Tests 4 and 5 to be described later.

(3) Guarantee of opacity

[0020] A predetermined amount of the filler is necessary to guarantee the opacity. Calcium carbonate as a filler was gradually added to pulp in an amount of 27 gsm which was a premise to guarantee the above strength properties, and then the relationship between the basis weight and the opacity was examined. The results are shown in FIG. 2.

[0021] From the results of FIG. 2, as for the use of only the calcium carbonate which is generally a filler, 8 gsm of calcium carbonate is necessary to achieve an appropriate value in opacity (80%). Therefore, in order to obtain the tipping base paper having an opacity of 80%, the minimum basis weight is set to 35 gsm (calcium carbonate: 23 wt%).

[0022] The inventors further performed the same test except that the whole amount of the filler was replaced with titanium oxide in order to examine the possibility to design the low basis weight. The results are written in FIG. 2. From FIG. 2, an appropriate value (80%) of the opacity could be achieved by 4 gsm of titanium oxide (TiO_2) namely, titanium oxide (TiO_2) having an amount much smaller than that of calcium carbonate, and tipping paper whose lower limit of basis weight was 31 gsm (titanium oxide: 13 wt%) could be obtained.

(4) Composition of tipping paper according to embodiment

[0023] From the above considerations (1) to (3), it was studied that the lower limit amount of pulp was set to 27 gsm and the content of titanium oxide as a filler was set to at least 4 gsm in order to guarantee strength properties. The relationship between the amount (gsm) of pulp shown in FIG. 3 and the volume of the filler (gsm) was drawn from the studied results. The tipping paper having a low basis weight (31 gsm or more and less than 35 gsm) was achieved by containing the basis weight in the slash area, i.e. pulp and titanium oxide, in FIG. 3, wherein when x represents the basis weight (gsm) of the pulp and y represents the basis weight (gsm) of the titanium oxide, x and y satisfy the following formula: $31 \leq x + y < 35$, where x and y are $27 \leq x < 31$ and $4 \leq y < 8$.

[0024] The tipping paper having a low basis weight according to the embodiment satisfies physical properties shown in Table 1 above and an appropriate value of function.

[0025] That is, tensile strength, stiffness, opacity, fire retardancy, and ink fixability are as follows:

- tensile strength: 26.0 N or more (required quality at the time of rolling);
- stiffness: loop stiffness of 2.0 or more (influence on defects of wrinkles of the rolled product);
- opacity: 80% or more (hiding of the dust of powder, appearance quality to be required for design);
- fire retardancy: (guarantee proper burning in the vicinity of the filter); and
- ink fixability: equal to that of a general-purpose product.

[0026] In the tipping paper having a low basis weight according to the embodiment, it is possible to improve the ink fixability when printing in a large area like cork by setting the sizing degree to 5 seconds or less.

[0027] That is, calcium carbonate, which is generally used as a filler, is structurally porous, and thus it is excellent in fixability of printing ink. Typographical problems such as the loss of ink are hardly caused. On the other hand, as for the tipping paper according to the embodiment in which the whole amount of calcium carbonate is replaced with titanium oxide as a filler, the ink fixability is relatively poor. Accordingly, when printing in a large area is performed at the time of producing cigarettes, ink is easily peeled off, thereby causing damages of products and the dirt of the machine.

[0028] Because of this, the ink permeability to the tipping paper was improved by setting the sizing degree to 5 seconds or less so as to be lower than the normal sizing degree (about 20 seconds). As a result, it is possible to improve the ink fixability without changing the ink formula. Note that the value of the sizing agent can be calculated with the Hercules sizing tester to be described later. In the tipping paper of the embodiment, the sizing degree includes zero.

Value measured with the Hercules sizing tester

[0029] This is a widely known method (TAPPI Provisional method T530-PM83), which was treated as a transitional law by TAPPI: the organization dedicated to the pulp and paper industries in 1975. In the present invention, a method of measuring with the device (Hercules Sizing Tester kc-294) was selected from many methods of measuring the sizing degree and the sizing degree was evaluated. When outlining this, a slip of paper for evaluation which was cut from the tipping paper was placed on the bottom of a folder of the wall of a metal ring so as to be wedged into the folder. Then, the folder was placed in the device, and a dye containing naphthol green as a base compound was poured thereinto. A measurement switch is started immediately after pouring the dye. After the penetration time specific to the slip of paper, the back side of the paper turned green (color of the stain solution). The time leading to a constant reflectance was recorded as the sizing degree (second). Note that the reflectance was set to 80% in this measurement.

[0030] The sizing degree can be lowered by keeping down the amount of a sizing agent to be added to the tipping paper. Examples of the sizing agent include an emulsion rosin size, rosin soap size, alkenyl succinic acid soap, fatty

acid sizing agent, alkyl ketene dimer, alkenyl succinic anhydride, rosin ester size, alkenyl ketene dimer, and styrene polymer size. These sizing agents can be used alone or in a mixture form. Among the sizing agents, an alkyl ketene dimer is preferable.

[0031] The tipping paper having a low basis weight (e.g. 32 gsm) according to the embodiment as described above exerts the following effects.

- The thickness of the tipping paper can be made thinner by 14% (decreased from a thickness of 43 μm to a thickness of 37 μm) than the general-purpose tipping paper (basis weight: 37 gsm). Thus, when the outer diameter of a bobbin which has rolled the tipping paper is set to a diameter equal to that of the general-purpose tipping paper, the diameter can be elongated by about 15% (increased from a length of 3000 mm to a length of 3500 mm). As a result, the production volume of cigarettes per bobbin at the time of producing cigarettes can be increased by about 15% and thus improvement in productivity can be achieved.
- Since the weight of the tipping paper can be decreased by 14% as compared to the general-purpose tipping paper (basis weight: 37 gsm), energy related to transportation is reduced. This is useful in the environment and transportation cost.
- When changed from the general-purpose tipping paper, it is possible to enjoy the usefulness and impart fire retardancy without a large increase in cost.
- When changed from the fire-resistant base paper having a basis weight of 37 gsm, it is possible to enjoy the usefulness and reduce the cost of the base paper.

[0032] Subsequently, the filter-equipped cigarette according to the embodiment will be described.

[0033] The filter-equipped cigarette according to the embodiment comprises the above tipping paper having a low basis weight.

[0034] A specific filter-equipped cigarette will be described in detail with reference to FIG. 4. The filter-equipped cigarette has a structure in which a cigarette rod 1 is faced to a filter 2, and the whole outer periphery surface of the filter 2 and the peripheral surface portion of the cigarette rod 1 in the face vicinity are rolled with a tipping paper 3 to unite the cigarette rod 1 with the filter 2. The cigarette rod 1 is formed by cylindrically rolling a cut tobacco 4 with a cigarette paper 5. The filter 2 comprises, for example, a filter material (not shown) formed by bundling and folding an acetate fiber or a pulp nonwoven fabric; and a plug wrapping paper (molding paper) 6 for cylindrically rolling the filter material. The tipping paper 3 comprises pulp, and titanium oxide as a filler, when x represents the basis weight (gsm) of the pulp and y represents the basis weight (gsm) of the titanium oxide, x and y satisfy the following formula: $31 \leq x + y < 35$, where x and y are $27 \leq x < 31$ and $4 \leq y < 8$.

[0035] As for such a filter-equipped cigarette according to the embodiment, its functional characteristics (tensile strength, stiffness, opacity, and fire retardancy) is maintained by the effect of the tipping paper having a low basis weight and thus low weight and low cost of the cigarette can be achieved.

[0036] Hereinafter, examples of the present invention will be described in detail. Note that a wood pulp obtained by mixing L and N materials at an appropriate ratio was used as a pulp material. Calcium carbonate which has an average particle diameter of 5 μm and titanium oxide which has an average particle diameter of 0.4 μm were used in the following examples.

(Example 1)

[0037] Four kinds of tipping paper having the composition shown in Table 2 below were prepared. Note that the sizing degrees of the tipping paper (Comparison 1, Tests 1 to 3) were adjusted to 21 seconds, 23 seconds, 23 seconds, and 23 seconds, respectively by adding an alkyl ketene dimer as a sizing agent. The tensile strength, stretch, stiffness, opacity, whiteness, and thickness of each tipping paper were measured by the following method. The results are shown in Table 2 below.

1) Tensile strength

[0038] A constant-rate-of-extension type tensile testing machine (tensilon type tensile testing machine) was used. Both longitudinal ends of 15-mm width slip of paper cut from the tipping paper were fixed to movable grips of the measuring machine. The movable sites were moved. The maximum load immediately before a slip of paper was cut at a constant speed was electrically detected and recorded in a unit of Newton (based on JIS P8113).

2) Stretch

[0039] A constant-rate-of-extension type tensile testing machine (tensilon type tensile testing machine) was used.

Both longitudinal ends of 15-mm width slip of paper cut from the tipping paper were fixed to movable grips of the measuring machine. The movable sites were moved. The maximum stretch immediately before a slip of paper was cut at a constant speed was electrically detected and recorded in a unit of percentage (based on JIS P8113).

3) Stiffness

[0040] A loop stiffness tester (manufactured by Toyo Seiki Seisaku-Sho, Ltd.) was used. Both longitudinal ends of 15-mm width slip of paper cut from the tipping paper were fixed to movable sites of the measuring machine. Thereafter, the interval between both ends at the movable sites was narrowed to produce a paper loop formed of a slip of paper with a length of 62 mm. The maximum stress when a sensor was applied to the paper loop was read by signal and recorded in a unit of g. The movable amount of the sensor to be applied to the paper loop was applied to a slip of paper and then the amount was set to 2 mm.

4) Opacity

[0041] Every slip of paper cut from the tipping paper was measured using a photovoltaic measuring instrument and the opacity was recorded in a unit of percentage.

5) Whiteness

[0042] Predetermined sheets of paper cut from the tipping paper were laminated not so as to cause the transmission of light from a light source and measured using a photovoltaic measuring instrument. The whiteness was recorded in a unit of percentage.

6) Thickness

[0043] A slip of paper cut from the tipping paper was measured with a digital micrometer and the thickness of every slip of paper was recorded in a unit of μm (based on JIS P8118).

Table 2

Sample name	Basis weight (gsm)	Composition of tipping paper			Physical properties of tipping paper					
		Amount of pulp (gsm)	Volume of filler (gsm)	Ratio of filler (%)	Tensile strength (N/ 15 mm)	Stretch (%)	Stiffness (g/ 15 mm)	Opacity (%)	Whiteness (%)	Thickness (μm)
Comparison 1	37	29.2	$CaCO_3$:7.8	21	32.4	1.4	3.4	80.0	93	43
Test 1	32	27.8	TiO_2:4.2	13	29.0	1.4	3.0	80.5	91	37
Test 2	33	28.7	TiO_2:4.3	13	31.2	1.5	3.2	80.9	91	38
Test 3	34	29.7	TiO_2:4.4	13	33.6	1.5	3.6	81.0	91	39

[0044] As is clear from Table 2 above, it is found that the tipping paper having a low basis weight (32 to 34 gsm) in Tests 1 to 3 of the present invention has functional characteristics not inferior to the tipping paper of Comparison 1, which is a general-purpose product having a basis weight of 37 gsm and containing calcium carbonate as a filler as well as high quality.

(Example 2)

[0045] Two kinds of tipping paper shown in Table 3 below were prepared. The amount of the pulp in the tipping paper was smaller than the lower limit amount of pulp of the present invention (27 gsm) and the beating degree was significantly increased for use. The tensile strength, stretch, stiffness, opacity, whiteness, and thickness of each tipping paper were measured in the same manner as described in Example 1. The results are shown in Table 3 below.

Table 3

Sample name	Composition of tipping paper				Physical properties of tipping paper				
	Basis weight (gsm)	Amount of pulp (gsm)	Volume of filler (gsm)	Ratio of filler (%)	Tensile strength (N/15 mm)	Stretch (%)	Stiffness (g/15 mm)	Opacity (%)	Whiteness (%)
Test 4	31	23.0	TiO_2: 8	26	33	1.5	0.9	80.6	90
Test 5	33	24.0	TiO_2: 8	24	29	1.3	0.8	80.1	90

[0046] As is clear from Table 3 above, although each of the tipping papers of Tests 4 and 5 has a low basis weight (31 gsm, 33 gsm), the amount of pulp is smaller (23.0 gsm, 24.0 gsm) than the lower limit amount of pulp of the present invention (27 gsm). Thus, it is found that a decrease in stiffness is significant in spite of the guarantee of tensile strength at a high beating degree described above.

(Example 3)

[0047] There were prepared the tipping paper of Comparison 1 (sizing degree: 21 seconds) and the tipping paper of Test 1 (sizing degree: 23 seconds) in Table 2 above, and the tipping paper of Test 6 (with a sizing degree of 5 seconds) having the same composition as that of Test 1 in Table 2 above and containing the adjusted additive amount of an alkyl ketene dimer as a sizing agent. The ink fixability of each of these tipping papers was examined by the following method. The results are shown in Table 4 below.

7) Ink fixability

[0048] As for the ink fixability, it is necessary to evaluate both wear resistance to rubbing and stability to peeling.

[0049] The wear resistance was measured using a JSPS (Japan Society for the Promotion of Science)-type fastness-to-rubbing tester. A friction block is configured to include a semicircular pillar-shaped friction block main body (size: 20 mm in length of the bottom portion × 20 mm in width, 45 mm in radius of curvature, 150 g in weight) and 200 g of cylindrical spindle (45 mm in diameter × 24 mm in height) attached onto the top curved surface of the friction block main body. A white test paper for observing the loss of ink having the same size as the bottom portion was attached to the bottom portion of the friction block main body of the friction block. A specimen subjected to printing (printed specimen) was fixed on a rectangular-shaped flat surface of a semicircular pillar-shaped stainless steel board with a curvature radius of 200 mm. In the wear resistance test, the friction block was placed and set on the printed specimen of the stainless steel board so that the white test paper was faced to the specimen. The friction block was subjected to each 50 times back and forth rubbing on the printed specimen. Then, the test paper was observed and the degree of loss color was evaluated.

[0050] As for the stability, a commercially available adhesive tape was stuck to the printed specimen with a weight of 100 g and the tape was immediately peeled off, and then the degree of loss color was observed.

[0051] In the ink fixability by such test, the case where significant transfer of ink to the white test paper or the adhesive tape was seen was judged as "poor", the case where slight transfer of ink was observed was judged as "good", and the case where transfer of ink was hardly observed or the paper was peeled off by the adhesive tape and the ink was peeled off for each layer of paper was judged as "very good".

Table 4

Sample name	Sizing degree (second)	Ink fixability
Comparison 1	21	Very good
Test 1	23	Good
Test 6	5	Very good

[0052] As is clear from Table 4 above, the tipping paper having a low basis weight (32 gsm) in Test 1 of the present invention has good ink fixability, even if the sizing degree is 23 seconds, while the tipping paper having a low basis weight (32 gsm) in Test 6 of the present invention whose sizing degree is set to 5 seconds exhibits good ink fixability at an equal level to that of the tipping paper (basis weight: 37 gsm) in Comparison 1 which is a general-purpose product with a sizing degree of 21 seconds.

(Example 4)

[0053] The tipping papers in Comparison 1 and Tests 1 and 3 of Table 2 above were applied to brand A and brand B (filter-equipped cigarettes), respectively. The fire retardancy of the brands A and B was examined by the following method. The results are shown in Table 5 below.

8) Fire retardancy

[0054] Cigarettes were horizontally attached to an automatic smoking machine (BORGWALD RM20/CS). Each cigarette was ignited for smoking once, followed by burning spontaneously until the cigarette was burn out. The fully burned cigarettes were observed. The cigarette in which the tipping paper was burned and the charcoal was fallen and the cigarette in which the charcoal was not fallen and the tipping paper was burned were counted. The ratios thereof were calculated. Note that the case where burning was clearly stopped at a level in which the distal end of the tipping paper on the side of the cigarette rod was slightly burned was judged to have fire-retardancy and taken off the count.

Table 5

Brand	Tipping paper classification	Percentage of fallen charcoal (%)	Percentage of burned tipping paper (%)
A	Comparison 1	5	65
Test 1	0	0	
Test 3	0	0	
B	Comparison 1	22	100
Test 1	5	25	
Test 3	5	25	

[0055] As is clear from Table 5 above, the filter-equipped cigarettes (brands A and B) using the tipping papers of Tests 1 and 3 are excellent in fire retardancy as compared to the filter-equipped cigarettes (brands A and B) using the tipping paper of Comparison 1.

Industrial Applicability

[0056] The present invention can provide a tipping paper in which the productivity of a filter-equipped cigarette is improved, and the improvement in the environment and transportation cost due to the low weight and the reduction in cost of a base paper are achieved; and a filter-equipped cigarette comprising the tipping paper in which functional characteristics (tensile strength, stiffness, opacity, and fire retardancy) to be required for the tipping paper are maintained, and low weight and low cost of the cigarette are achieved.

Claims

1. A tipping paper comprising pulp, and titanium oxide as a filler, wherein when x represents a basis weight (gsm) of the pulp and y represents a basis weight (gsm) of the titanium oxide, x and y satisfy the following formula:

$$31 \leq x + y < 35,$$

where x and y are $27 \leq x < 31$ and $4 \leq y < 8$.

2. The tipping paper according to claim 1, further comprising an alkyl ketene dimer as a sizing agent.

3. The tipping paper according to claim 2,
wherein the sizing degree is 5 seconds or less.

4. A filter-equipped cigarette comprising the tipping paper according to claim 1.

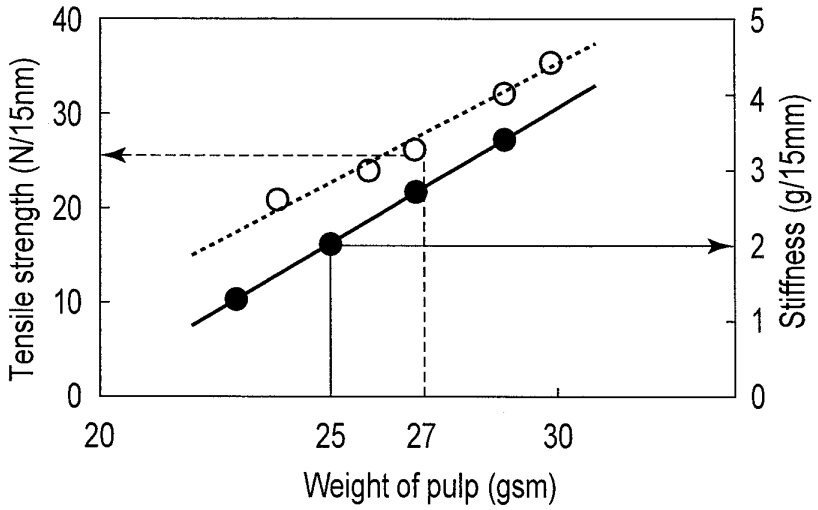
Tensile strength (N/15nm)
Stiffness (g/15mm)
Weight of pulp (gsm)
40
30
20
10
0
5
4
3
2
1
0
20
25
27
30

FIG. 1

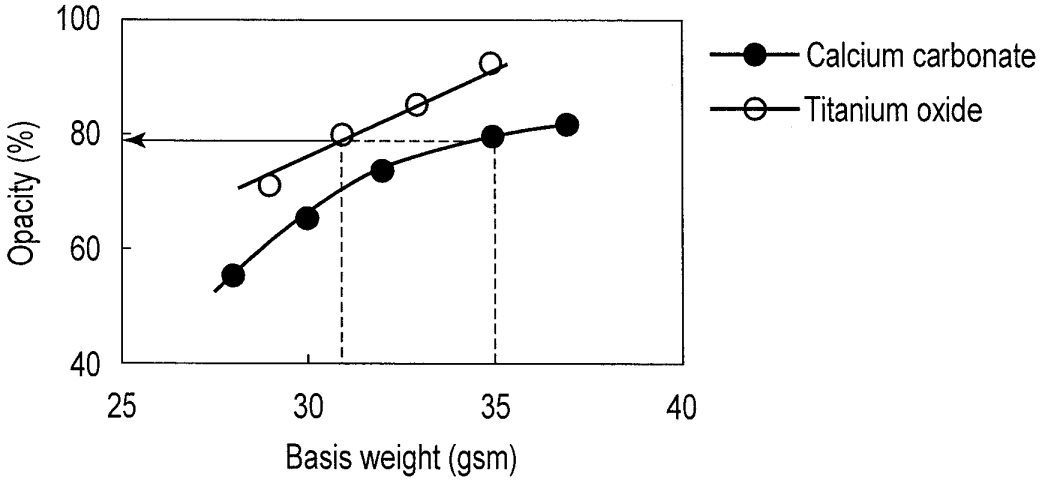
Opacity (%)
Basis weight (gsm)
100
80
60
40
25
30
35
40
Calcium carbonate
Titanium oxide

FIG. 2

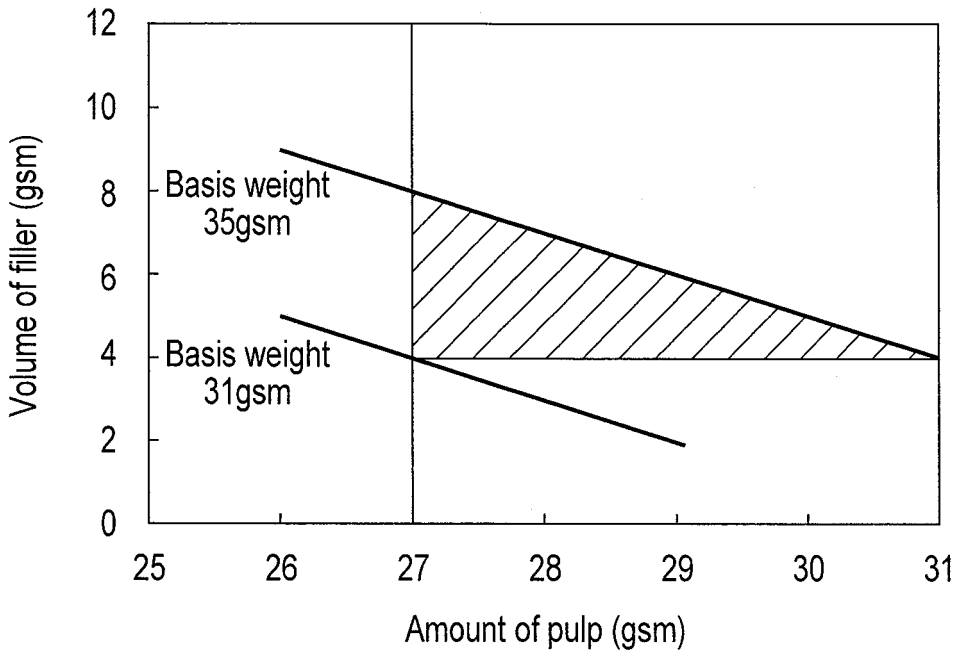
12
10
8
6
4
2
0
Volume of filler (gsm)
Basis weight
35gsm
Basis weight
31gsm
25
26
27
28
29
30
31
Amount of pulp (gsm)

FIG. 3

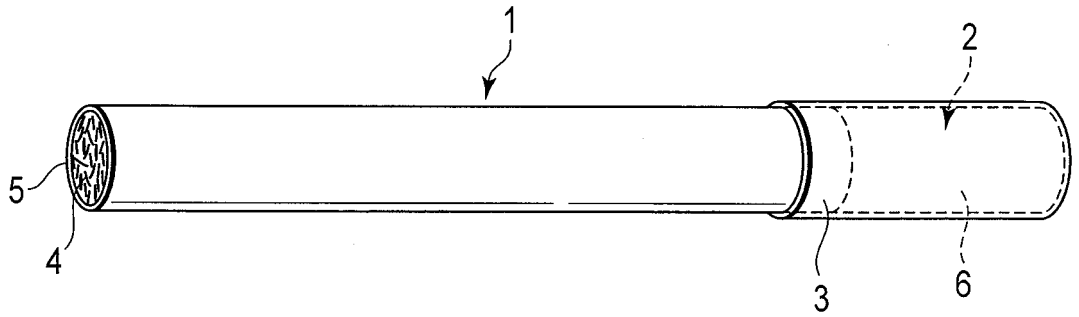
1
2
5
4
3
6

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/054880

A. CLASSIFICATION OF SUBJECT MATTER
D21H27/00(2006.01)i, *A24D1/02*(2006.01)i, *A24D1/10*(2006.01)i, *D21H21/34*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D21B1/00-1/38, D21C1/00-11/14, D21D1/0-99/00, D21F1/00-13/12, D21G1/00-9/00, D21H11/00-27/42, D21J1/00-7/00, A24D1/00-3/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010
Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 08-246396 A (Mishima Paper Co., Ltd.), 24 September 1996 (24.09.1996), claims 2, 8; examples 1, 5, 6, 8 (Family: none)	1-4
Y	JP 2001-159098 A (Schweitzer-Mauduit International, Inc.), 12 June 2001 (12.06.2001), claims 1, 3, 15; paragraphs [0001], [0004], [0005], [0025]; examples & EP 1093727 A2	1-4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 June, 2010 (08.06.10)	22 June, 2010 (22.06.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2875184 B **[0004]**
- JP 10219599 A **[0005]**