

PATENT SPECIFICATION

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(54) IMPROVEMENTS RELATING TO PENCILS

- (71) WE, TEIJIN LIMITED, a Japanese Body Corporate of No. 1 Umeda, Kita-ku, Osaka, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- This invention relates to a raw batch for pencil casings, comprising a mixture of polystyrene, polyethylene glass fibres and a blowing agent a pencil casing produced from the raw batch, and a pencil having the pencil casing.
- A pencil consists of a writing core and a casing surrounding the core. The casing serves not only to protect the core, but also to permit the formation of a new sharpened core upon sharpening. Hence, the pencil casing is required to have a rigidity necessary for preventing the breakage of the core upon bending caused by a pressure which is exerted on the casing during writing and a sharpenability with sharpening instruments.
- Special natural woods, such as incense cedar occurring in North America, have been used as a material for pencil casing. Incense cedar has proved superior both in rigidity and sharpenability as a material for production of pencil casings. Such natural woods, however, are susceptible to ambient temperatures and humidities, and often result in the warping or bending of the finished pencil casing. Furthermore, in recent years, the cost of production of pencils has been rapidly increasing because of an increased cost of slats for pencil casings.
- Attempts have therefore been made to replace pencil casings by plastics, but have not been successful to date. Plastic materials so far tested have not proved satisfactory in both of the rigidity and sharpenability mentioned above.
- Extensive work by the inventors of the present invention shows that a pencil casing should desirably have sharpenability comparable to that of incense cedar, but need not have rigidity equal to that of incense cedar. The rigidity which incense cedar possesses is excessive for use in pencil casings. If the rigidity of incense cedar is expressed by a flexural modulus, it is as high as 60000 - 80000 Kg/cm² measured in the form of a casing. However, pencil casing materials do not require such a high rigidity for practical use. Rigidity in excess of 30000 Kg/cm² is satisfactory for practical purposes. Accordingly, if a plastics material having an excellent sharpenability comparable to that of incense cedar and a flexural modulus in excess of 30000 Kg/cm² is developed, it can replace the conventional casing materials.
- Attempts have previously been made to produce the pencil casing with polystyrene foams or ABS resin foams. These plastic materials can provide feasible sharpenability by raising the degree of foaming, but cannot meet the rigidity requirement mentioned above. This is because polystyrene or ABS resin even in the non-foamed state has a flexural modulus of at most about 30000 Kg/cm², and the foamed products thereof naturally has a far lower flexural modulus.
- A primary object of this invention is to provide a raw batch which is capable of producing a plastics pencil casing having sharpenability comparable to that of incense cedar and a flexural modulus in excess of 30000 Kg/cm².
- A further object of this invention is to provide a method of producing pencils at low cost by a simple process, using such a raw batch. It has now been found that a mixture in proper proportions of polystyrene, polyethylene and glass fibers, together with a proper amount of a blowing agent (e.g. 0.2-1.5% by weight based on the total

[Price 25p]

of polystyrene, polyethylene and glass fibres) is a raw batch which satisfies the above-mentioned requirements. The mixing proportions are 10 - 40 parts by weight of polyethylene and 10 - 55 parts by weight of glass fibers per 100 parts by weight of polystyrene. The polystyrene used in the present invention may be any of GP polystyrene which is a transparent homopolymer of styrene, HI polystyrene modified with butadiene rubber or styrene butadiene rubber for improving impact strength, or a copolymer of styrene with a small amount of other monomer. Usually, GP polystyrenes with a molecular weight of 90,000 to 350,000 are most suitable. The polyethylenes used in the present invention may be of low, medium, and high densities. In respect of sharpenability, low density polystyrenes give the best results. The melt index of the low density polyethylene should better be higher for attaining good sharpenability but such polyethylene has a decreased flexural modulus. Hence, the melt index should preferably be selected within a range of about 0.3 to 20 g/10 minutes.

The glass fibers that are used in the present invention are not particularly limited, but those preferred are of the chopped strand type in which the diameter of the single filament is 5 - 15 microns, and the cut length is 1 - 10 mm. Those glass fibers whose surfaces have been treated with a silane-type compound are naturally desirable.

If the amount of polyethylene per 100 parts by weight of polystyrene is less than 10 parts by weight, the sharpenability of the resulting casing is extremely reduced, and the casing cannot withstand use in practical applications. Amounts in excess of 40 parts by weight improve the sharpenability of the resulting pencil casing, but result in a drastic decrease in flexural properties, especially flexural strength. In addition, a raw batch containing such an excessive amount of polyethylene is difficult to fabricate into a pencil casing.

If the amount of glass fibers is less than 10 parts by weight, it is impossible to obtain a pencil casing having a flexural modulus of above 30000 Kg/cm². If the amount of glass fibers is as high as above 55 parts by weight, it becomes abruptly difficult to fabricate the raw batch into a pencil casing, but in spite of this the flexural properties of the casing are not improved.

The raw batch for the production of plastic pencil casings can be, for example,

(1) Mere mechanical mixture consisting of polystyrene particles (for example, pellets), polyethylene particles (for example, pellets or powders), glass fibers (for example, chopped

strand) and the blowing agent, or
(2) Pellets obtained by melting, kneading, and extruding the mixture (1) in the same way as in the production of glassfiber-reinforced thermoplastic resin pellets by the dispersion method.

The plastics pencil casing in accordance with the present invention is produced by fabricating a raw batch such as (1) or (2) mentioned above on an extruder for production of pencil casings, with foaming. Usually, the use of raw batch (2) is suitable from the standpoint of operability, shapability, and the quality of the resulting casing. The following description will therefore be made with reference to an embodiment in which to use pellets (2) illustrated above.

To ensure that the sharpenability of the pencil casing obtained by using the raw batch of this invention is comparable to that of incense cedar, the casing should be a foamed article. It is necessary therefore to have a chemical blowing agent in the pellets (2) illustrated above, and fabricate the resulting mixture while allowing foaming. In addition to the effect of increased sharpenability, the foaming of the pencil casing can compensate for an increased specific gravity caused by the inclusion of glass fibers.

Examples of suitable chemical blowing agents that can be used in the invention include azodicarbonamide, p,p'-oxybis(benzenesulfonyl hydrazide), dinitrosopentamethylene tetramine, or p-toluene sulfonyl semicarbazide. Usually, the use of azodicarbonamide is preferred. When such a blowing agent is used, it is customary to use various compounds such as zinc or cadmium compounds conjointly in order to control the decomposition temperature of the blowing agent. The amount of the blowing agent that proves suitable is about 0.2 to 1.5 % based on the total weight (weight of pellets) of polystyrene, polyethylene and glass fibers. The method of using the blowing agent will be described in the Examples which will appear later on.

There can be conceived two methods of producing pencils from the raw batch of the invention.

(a) Method comprising first forming a pencil slat by the extrusion molding of the raw batch of the invention containing a blowing agent, and producing pencils in the same way as in the conventional pencil making technique.

(b) Method in which the raw batch of the invention is coated on a writing core by extrusion molding while allowing foaming, in the same way as in the extrusion coating of electric wires (to be termed the simultaneous fabricating method).

Specifically, method (a) comprises extrusion-molding the raw batch of the invention containing a blowing agent to form a foamed plate, cutting out slats from said plate, forming a plurality of (usually six) parallel grooves for writing cores on one surface of the slat, said grooves having a depth substantially equal to the radius of the writing core, bonding two grooved slats while positioning writing cores within the grooves of said slats, and thereafter, cutting off the unwanted portions of the slats to form a pencil. This method is technically easy to perform, but results in a great loss of the material, which makes the cost of production even higher than in the case of producing pencils using incense cedar.

On the other hand, the method (b) encounters some technical difficulty, and does not permit continuous molding with ease because the length of a conventional pencil core produced by calcining a mixture of graphite and clay at around 1000°C. is less than about 20 cm.

Extensive study of the method (b) has now led to a method of producing pencils which comprises continuously extruding a writing core containing plastics as a binder, and extruding the raw batch of the invention containing a blowing agent continuously along and around said writing core while allowing foaming. This method will be described in greater detail in the Examples. By using this method which is based on the extrusion coating of electric wires, pencil casings having sharpenability comparable to that of incense cedar and feasible rigidity can be produced continuously at low cost.

An antistatic agent such as alkylamine/ethylene oxide adducts or polyethylene glycol may be incorporated in an amount of about 1 % by weight in the raw batch of the present invention in order to prevent sharpened dusts from flying away due to the generation of static charge on plastics when the pencil is sharpened with an electric sharpener. Suitable dyes or pigments may also be added in order to give a wood-like appearance to the casing. Furthermore, any other additives for plastics may be incorporated as desired.

The invention will now be described by the following non-limitative Examples. All parts are by weight unless otherwise specified.

In each of the Examples, the sharpening resistance value was determined as follows:
A sharpener rotating by a motor is urged against the tip of a fixed sample pencil to sharpen it, and the maximum input (watts) of the motor at this time is measured using a sharpening resistance tester described in JIS S6006-1959 (pencil testing

method). The input (watts) of the motor at the time when the pencil is not sharpened is subtracted from the maximum input (watts), and the result is the sharpening resistance value. Smaller sharpening resistance values mean greater ease of sharpening the pencil. But since this sharpening resistance value varies with the size of the cutter, the output of the motor, urging pressure, etc., the absolute value itself is not so significant. Hence, the evaluation of the sharpenability should be made by comparing the sharpening resistance values of two or more pencils which have been measured under the same conditions. In the following Examples, the sharpening resistance values were determined under the same conditions.

Example 1

1) Production of Raw Batch (prior to the addition of blowing agent).

A mechanical mixture of 100 parts of polystyrene pellets (Styron 666, styrene homopolymer of Asahi Dow Company—"STYRON" is a Registered Trade Mark), 25 parts of polyethylene pellets (high pressure, melt index 7.0 g/10 minutes), and 53 parts of glass fibers (treated with aminosilane, chopped strand in which the individual fibers have a diameter of 13 microns and a cut length of 6 mm) was put continuously into a hopper of a 68 mm extruder equipped with a Dulmage-type screw, and extruded into the form of strand at about 220°C. After cooling with water, the extruded product was cut to form the raw batch (pellets) of the invention in the form of cylinders with a diameter of about 3.0 mm and a length of 4.0 - 5.0 mm.

2) Production of Writing Core Material Containing Plastic Binder

Using a V-type blender, 2.0 parts of commercially available ABS resin powders (obtained by emulsion polymerization, with a butadiene rubber content of 15 %), 7.0 parts of natural crystalline graphite powders (average particle size 7.0 microns) and 1.0 part of calcium stearate were thoroughly mixed. After drying, this mixture was extruded at about 170°C. using a 30 mm extruder, and cut while hot to form material for production of pencil cores.

3) Fabrication of Pencil (by Simultaneous Fabricating Method)

One hundred parts of the raw batch (pellets) obtained in 1) above and 0.8 part of polyethylene glycol having a molecular weight of 400 were tumbled for 15 minutes, and then 0.5 part of azodicarbonamide, 0.35 part of zinc oxide powders, 0.35 part of talc powders, and 0.03 part of a pigment were added at a time. The tumbling was performed for additional 15 minutes. The re-

sulting raw batch of the invention was extruded through a 40 mm extruder equipped at its tip with a cross head die similar to the die for extrusion coating of electric wires, under the following temperature conditions.

	rear portion (on the side of the hopper)	155°C.
	intermediate portion	165°C.
10	front portion	165°C.
	die	160°C.

Simultaneously, the core material produced in 2) above was extruded at 150 - 160°C. through a 30 mm extruder equipped with a die having a 2.0 mm diameter circular hole to form a 2.0 mm diameter core of indefinite length, and the resulting core was continuously introduced into a core introducing opening of the cross head die. The extrudate obtained above using the 40 mm extruder was coated continuously on the core material formed in a manner to surround said core. The product was withdrawn from a cross head die having a hole diameter of 7.0 mm. Then the product was molded by a forming die into a dimension of ordinary pencil (hexagonal cross section with a length of one side being about 3.8 mm), cooled through a water cooling bath, and cut to a length of 175 mm. Thus, the pencil of the present invention was obtained.

One such pencil weighed about 7.3 g, which is heavier than a pencil produced using an incense cedar material (about 4.0 g). This difference in weight does not pose a problem in practical use. The pencils obtained could be readily sharpened as in the conventional pencils by any of electric sharpeners and knives. The sharpening resistance value was 0.40 - 0.60 watt (that of the incense cedar being about 0.40 - 0.60 watt). When a pencil of about 500 m length (corresponding to about 3000 pencils) was continuously sharpened, there was no trouble caused in the sharpener. Furthermore, even when letters were written with this pencil, the casing was neither bended nor warped. The casing was found to have a flexural modulus of about 40000 Kg/cm² and an apparent density of about 0.87 g/cm³.

55 Example 2

The procedure of Example 1 was repeated except that low density polyethylene having a melt index of 20 g/10 minutes was used instead of the high pressure polyethylene used in Example 1. The resulting pencil had good sharpenability, and a sharpening resistance value of 0.35 to 0.55 watt. The casing of this pencil had an apparent density of 0.86 g/cm³, and a flexural modulus of 38000 Kg/cm².

Example 3

The procedure of Example 1 was repeated except that as the polystyrene, high impact polystyrene (Styron 475, product of Asahi Dow Company) was used. The resulting pencil had the same sharpenability as that of a pencil produced using an incense cedar material, and a sharpening resistance value of 0.40 - 0.55 watt. The casing of the pencil had a flexural modulus of 33000 Kg/cm² and an apparent density of 0.90 g/cm³.

Example 4

The procedure of Example 1 was repeated except that as the polyethylene, high density polyethylene having a melt index of 6.0 g/10 minutes was used. The resulting pencil had a sharpening resistance of 0.50 - 0.70 watt, and its casing had an apparent density of about 0.92 g/cm³ and a flexural modulus of 50000 Kg/cm².

Example 5

In substantially the same way as set forth in Example 1, pencils were produced using a raw batch consisting of 100 parts of polystyrene (same as in Example 1), 25 parts of polyethylene (same as in Example 1) and 11 parts of glass fibers (same as in Example 1). The temperature of the 40 mm extruder was slightly raised or lowered, and the degree of foaming was changed to produce pencil casings having different apparent densities. Investigation of the relation between the apparent density and the flexural modulus indicated that the flexural modulus of above 30000 Kg/cm² cannot be ensured unless the apparent density is above about 0.90 g/cm³. It can therefore be seen that if the amount of glass fibers is reduced beyond that specified above, the casing has a flexural modulus if less than 30000 Kg/cm². When the apparent density of the casing was 0.90 g/cm³, its cut resistance value was 0.35 - 0.55 watt.

Example 6

Using a raw batch (A) consisting of 100 parts of polystyrene (same as in Example 1), 11 parts of polyethylene (same as in Example 1), and 50 parts of glass fibers, and a raw batch (B) consisting of 100 parts of polystyrene (same as above), 39 parts of polyethylene (same as above), and 55 parts of glass fibers (same as above), pencils of which casings had an apparent density of 0.85 g/cm³ were produced. The flexural modulus of the casing was 45000 Kg/cm² for (A), and 30000 Kg/cm² for (B). It is seen from this that in order to produce pencils that can be used for practical purposes, the amount of polyethylene cannot be increased beyond that contained in the raw batch (B) illustrated above.

The pencil from raw batch (A) had a sharpening resistance of 0.50 - 0.75 watt which is just a little bit higher than that of a pencil from an incense cedar material, but proved easy to sharpen in actual use. The pencil from raw batch (B) was easier to sharpen than a pencil from an incense cedar material, and had a sharpening resistance of 0.30 - 0.45 watt.

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WHAT WE CLAIM IS:

1. A raw batch suitable for use in the preparation of pencil casings which comprises 100 parts by weight of polystyrene, 10 to 40 parts by weight of polyethylene, 10 to 55 parts by weight of glass fibers, and a blowing agent.

2. A raw batch according to claim 1 which contains 0.2 to 1.5% by weight, based on the total weight of the polystyrene, polyethylene and glass fibers, of a blowing agent.

3. A raw batch according to claim 2 wherein the blowing agent is azodicarbonamide.

4. A raw batch according to claim 1, 2 or 3 wherein the polystyrene is a styrene homopolymer.

5. A raw batch according to claim 1, 2 or 3 wherein the polystyrene is a polystyrene modified with butadiene rubber.

6. A raw batch according to claim 1, 2 or 3 wherein the polystyrene is a polystyrene modified with a styrene-butadiene rubber.

7. A raw batch according to any one of the preceding claims wherein the polyethylene is low density polyethylene.

8. A raw batch according to any one of claims 1 to 6 wherein the polyethylene is high density polyethylene.

9. A raw batch according to any one of the preceding claims which contains an antistatic agent.

10. A raw batch according to claim 1 substantially as hereinbefore described.

11. A raw batch according to claim 1 substantially as described in any one of the foregoing Examples.

12. A porous pencil casing produced from a raw batch as claimed in any one of the preceding claims.

13. A method of producing a pencil, which comprises extruding a raw batch as claimed in any one of the preceding claims to produce a foamed plate, cutting away slats from said plate, forming a plurality of parallel grooves for writing cores having a depth substantially equal to the radius of the writing core on one surface of the slats, bonding two grooved slats with the writing cores positioned within said grooves, and thereafter cutting away the unwanted portions of the slats to form pencils.

14. A method according to claim 13 substantially as hereinbefore described.

15. A pencil produced by a process as claimed in claim 13 or 14.

16. A method of producing a pencil, which comprises continuously extruding a writing core containing a binder, and continuously extruding around the writing core a raw batch as claimed in any one of claims 1 to 11 to produce a foamed pencil case around the core.

17. A method according to claim 16 substantially as described in any one of the foregoing Examples.

18. A pencil produced by a process as claimed in claim 16 or 17.

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The pencil from raw batch (A) had a sharpening resistance of 0.50 - 0.75 watt which is just a little bit higher than that of a pencil from an incense cedar material, but proved easy to sharpen in actual use. The pencil from raw batch (B) was easier to sharpen than a pencil from an incense cedar material, and had a sharpening resistance of 0.30 - 0.45 watt.

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WHAT WE CLAIM IS:

1. A raw batch suitable for use in the preparation of pencil casings which comprises 100 parts by weight of polystyrene, 10 to 40 parts by weight of polyethylene, 10 to 55 parts by weight of glass fibers, and a blowing agent.

2. A raw batch according to claim 1 which contains 0.2 to 1.5% by weight, based on the total weight of the polystyrene, polyethylene and glass fibers, of a blowing agent.

3. A raw batch according to claim 2 wherein the blowing agent is azodicarbonamide.

4. A raw batch according to claim 1, 2 or 3 wherein the polystyrene is a styrene homopolymer.

5. A raw batch according to claim 1, 2 or 3 wherein the polystyrene is a polystyrene modified with butadiene rubber.

6. A raw batch according to claim 1, 2 or 3 wherein the polystyrene is a polystyrene modified with a styrene-butadiene rubber.

7. A raw batch according to any one of the preceding claims wherein the polyethylene is low density polyethylene.

8. A raw batch according to any one of claims 1 to 6 wherein the polyethylene is high density polyethylene.

9. A raw batch according to any one of the preceding claims which contains an antistatic agent.

10. A raw batch according to claim 1 substantially as hereinbefore described.

11. A raw batch according to claim 1 substantially as described in any one of the foregoing Examples.

12. A porous pencil casing produced from a raw batch as claimed in any one of the preceding claims.

13. A method of producing a pencil, which comprises extruding a raw batch as claimed in any one of the preceding claims to produce a foamed plate, cutting away slats from said plate, forming a plurality of parallel grooves for writing cores having a depth substantially equal to the radius of the writing core on one surface of the slats, bonding two grooved slats with the writing cores positioned within said grooves, and thereafter cutting away the unwanted portions of the slats to form pencils.

14. A method according to claim 13 substantially as hereinbefore described.

15. A pencil produced by a process as claimed in claim 13 or 14.

16. A method of producing a pencil, which comprises continuously extruding a writing core containing a binder, and continuously extruding around the writing core a raw batch as claimed in any one of claims 1 to 11 to produce a foamed pencil case around the core.

17. A method according to claim 16 substantially as described in any one of the foregoing Examples.

18. A pencil produced by a process as claimed in claim 16 or 17.

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