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INTERMITTENTLY-CRIMPED FILAMENT AND THE METHOD
FOR THE PRODUCTION THEREOF
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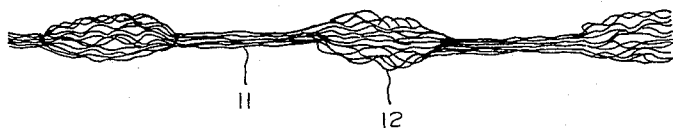


FIG. 1

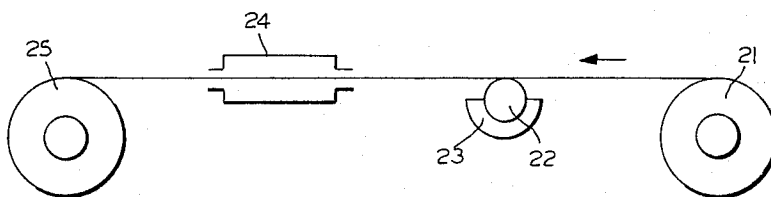


FIG. 2

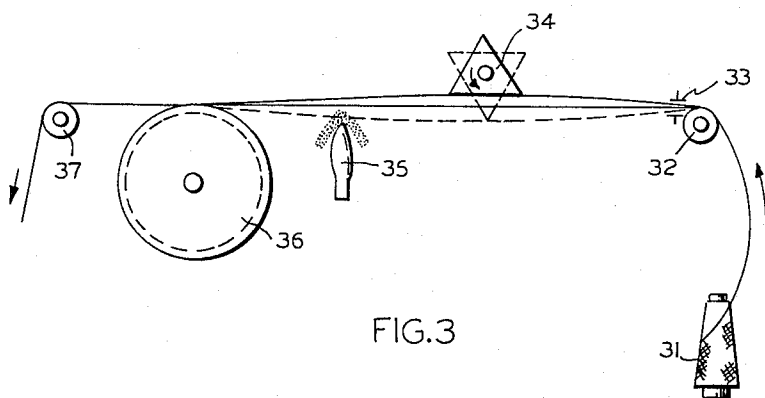


FIG. 3

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INTERMITTENTLY-CRIMPED FILAMENT AND THE METHOD FOR THE PRODUCTION THEREOF

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This invention relates to a novel intermittently-crimped filament yarn and the process for producing the same. More particularly, it relates to intermittently-crimped woolly yarns which can be obtained by intermittently eliminating the crimp of a crimped filament yarn comprised of thermoplastic synthetic fiber, and the method for producing the same.

Synthetic fibers are made into the form of fiber by spinning and the fibers thus formed by means of spinning and drawing take a shape of a straight line. This filament yarn having no crimp is fitted to the use for ladies' stockings, fishing nets and light fabrics. On the other hand, a crimped yarn having bulkiness has advantages that it is soft, possesses a great stretchability and a good heat retaining property and can be used for producing thick knitted or woven goods. It is, therefore, suited for making socks, underwears, etc.

While a crimped bulky yarn has the advantages as above, at the same time it has shortcomings that the stretchability thereof is too great and because of the general nature of the bulkiness, no variety of modified knitting or weaving is possible with the crimped yarn. However, it is conceivable that if the crimp of a crimped yarn is partially set, it may be possible to obtain the products of modified knitting or weaving whereby a proper degree of bulkiness and stretchability is imparted to the product. Thus, by adopting desirable properties such as bulkiness and stretchability, while eliminating undesirable properties of a crimped yarn, lace-like open-worked patterns are formed on the surface of the product or structural partial differentiation is effected on the surface or in the interior of the fabric. Namely, an intermittently crimped yarn in which a bulky part and a non-bulky part are formed on said yarn in a proper mixture may be thought of. In order to obtain such an intermittently crimped yarn, one may easily strike on the idea of a method in which a crimped yarn is intermittently applied with resin finishing, and by the action of the resin film thus formed on the yarn, the treated parts of monofilaments are adhered together and then heat set.

However, the adhesion effected by resin finishing has disadvantages that when a resin-finished yarn is dyed, dyeing irregularity is caused and because of the latent crimping property of the yarn, the resin is stripped off by laundry or abrasion, thereby the adhesion effect is lost, and also because of the resin adhered to the yarn, the touch of the yarn is inferior.

An object of this invention is to provide an intermittently-crimped filament yarn which is characterized by having a crimped-part and a crimp-released part in alternation.

Another object of this invention is to provide a method for producing an intermittently crimped filament yarn which comprises intermittently eliminating the crimp of a crimped filament yarn of thermoplastic fibers.

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Other objects and merits of this invention will become apparent from the description given in the following.

Thermoplastic fibers to be used in this invention are the filament yarns consisting of thermoplastic synthetic fibers such as, for example, polyamides such as polycapromide and polyhexamethylene adipamide, polyesters such as polyethylene terephthalate, polyolefines such as polypropylene and polyethylene, and polyacrylonitrile and the modifiers thereof. These filament yarns may be made into crimped yarns by means of crimping and heat setting the yarns. Various methods are known to obtain crimped yarns. Following are the examples of them.

A method of imparting crimps to a yarn which comprises the steps in sequence of false twisting a yarn, heat setting, then cooling, thereby setting the twist and thereafter untwisting the same. Another method of crimping a yarn comprises twisting thermoplastic synthetic fibers, heat setting and cooling the same so as to set the twist thereof and thereafter untwisting and heat setting the same. Still another method of imparting crimps to a yarn is that wherein thermoplastic synthetic fibers are twisted, heat set, untwisted, and thereafter twisted in a direction opposite to the first twisting, heat set, untwisted and once again heat set. In accordance with the above twisting and heat-setting methods, the yarns thus obtained are bulky, soft and have a good stretchability of as much as about 400%.

Also, as still another method of producing a crimped yarn, there is a method wherein a stuffing box is used. Namely, in this method, thermoplastic synthetic fibers are heated and continuously stuffed into a stuffing box, thus crimps are imparted to the fibers after which said fibers are cooled and taken out of the stuffing box through an exit.

In addition, there is a method of obtaining a crimped yarn by running thermoplastic synthetic fibers in such a manner that the fibers may come into an intimate contact with a heated sharp blade. There is another method wherein a yarn is knit with the use of a circular or a flat knitting machine and the thus obtained knitted fabric is heat set in its knitted state and then unknit, thus producing a crimped yarn.

There are still other methods modified from each of the above-described methods.

The crimped yarns usable in this invention may be prepared by means of any of the above methods, but a crimped yarn obtained by the twisting methods is particularly suitable.

According to the present invention, a crimped yarn of thermoplastic synthetic fibers obtained by the methods as described above is under tension intermittently adhered with a treatment liquor containing therein a compound which has at least a swelling property to said thermoplastic synthetic fibers, and heat treated under tension, thus releasing the crimp of the treated part of said yarn. An intermittently crimped yarn of this invention in which crimps are intermittently released is thus obtained.

Referring to the appended drawing, FIG. 1 shows an example of the products obtained in accordance with the present invention;

FIGURE 2 illustrates an embodiment for practicing the method of this invention; and

FIGURE 3 illustrates an embodiment for practicing the method of this invention.

In FIGURE 1, the reference numeral 11 shows a crimped part and numeral 12 shows a crimp-released part. The crimped part is bulky and stretchable. The intermittently-crimped filament yarn of this invention may be imparted a proper degree of stretchability and bulkiness by adjustably combining a crimped part and a crimp-released part thereof; and when said yarn is knit or woven

into a fabric, a beautiful fabric is obtained, the surface of which is open-worked like a lace, or the structure of which is partially differentiated on the surface or in the interior of the fabric.

A crimped filament yarn to be treated according to the method of this invention is continuously running under tension, as illustrated in FIGURE 2, numerals 21 to 25. 22 shows an engraved roller rotating in the running direction of the crimped filament yarn and makes an intermittent supply to the yarn of a treatment liquor which is fed from a treatment liquor tank 23. As the yarn under tension passes through a heating zone 24, the crimp of the yarn is released only at the part treated with the treatment liquor.

In the method of this invention, the crimped filament yarn usable as the starting material can be any of the crimped filament yarns produced by an optional method from fiber-forming thermoplastic synthetic resins such as polyamines, polyesters, polyolefines and polyacrylonitriles. Said starting crimped yarn possesses crimps uniformly along the longitudinal direction thereof, is bulky and has good stretchability. Said yarn is made continuously and is run in a state of being drawn under tension. In the method of this invention there is no special limitation set up as to the procedures or apparatus for effecting the continuous running of the yarn. Those procedures and apparatus which have conventionally been used in the industry of this field or those which are considered to be proper may be employed. As for the running speed of a yarn also, no special limitation is imposed, but the yarn may be run at such a speed that a treatment liquor is continuously and intermittently adhered to the yarn.

Treating agents to be used in this invention should possess an action of releasing the crimp of the starting crimped filament yarn. The treating agent having such an action is a liquid containing a compound having at least a swelling action to thermoplastic synthetic resins. The liquid must not dissolve the crimped yarn being treated but have a capacity to swell the same. Particularly, a solution which has been obtained by dissolving the synthetic resin which is a constituent of the crimped yarn to be treated in a solvent thereof in a concentration of less than about 5%, generally 2%, may be suitably used as a treating agent in the method of this invention. In employing such a solution as a treating agent, not only does the solution possess a proper degree of viscosity, but also at room temperature it scarcely dissolves, the yarn being treated, but manifests such a good effect as to finely act on the yarn being treated in a very short period of time when said yarn passes through a heating zone, and changes the molecular arrangement of the treated part of the yarn, thereby attaining the desired release of the crimp thereof. By the treatment with the use of such a resin solution as a treating agent, it becomes possible to carry out the method of invention favorably without causing partial breaks of the filaments.

The compounds usable as treating agents in the method of this invention are those which have at least a swelling action towards thermoplastic synthetic resins of which the crimped yarn to be treated is constituted. In case that said thermoplastic synthetic fibers are polyamides, there may be used as a treating agent, for example, formic acid, phenols such as, for example, phenol xylenol, chlorophenol, cresol, saturated solution of calcium chloride or zinc chloride in methanol, benzyl alcohol, glacial acetic acid, ethylene chlorohydrin, ethylene-glycol, cyclopropanol, cyclopentanone, cyclohexane, acetone, 2% solution of hydrogen chloride in methanol, saturated aqueous solution of benzoic acid, aqueous solutions of phenols and the like.

In case that said thermoplastic synthetic fibers are polyesters, there can be cited as a treating agent, for example, monochlorobenzene, dichlorobenzene, methyl-naphthalene, benzyl alcohol, benzoic acid, salicylic acid, phenyl-phenol, methyl benzoate, methyl salicylate, tetralin, phenol

methacresol, tetrahydronaphthalene, tetrachloroethane, chloroform, nitrobenzene, dimethylformamide, ethylene chloride, formic acid, benzyl acetate, acetone, dichlorobenzene, esters of acetic acid, acetaldehyde, chlorophenol, tetrachloroethane+phenol, trichlorophenol+tetrachlorophenol, etc.

Also, when said fibers are polyolefines, carbon tetrachloride benzene, gasoline, toluene, ethyl ether, etc. may be used as a treating agent.

When said fibers are polyacrylonitriles, sodium thiocyanate, sodium iodide, potassium iodide, potassium bromide, zinc chloride, magnesium chloride, barium chloride, ethylene carbonate, dimethyl sulfone, etc. dissolved in water, methyl alcohol, ethyl alcohol or benzene may be used as a treating agent.

In addition, when said fibers are cellulose acetate, acetone, amyl acetate may be used as a treating agent.

The swelling agents which can be used in the present invention are not limited to those given in the above, but any other liquids which possess a property of swelling said thermoplastic synthetic fibers may be used.

As already mentioned in the above, the treating agents suitably usable in the method of this invention are the resin solutions obtained by dissolving into the solvents of the thermoplastic synthetic resins which constitute the crimped yarn to be treated said resins, of which concentration may, in most cases, sufficiently be less than 2% by weight of the solution, but in some cases up to 5% of concentration may be used. The adhesive force of these resin solutions to be used in this invention is extremely weak. Also, the treatment of the crimped filament yarn of polyester with the use of a solution of polyamide does not give the desired effect of crimp releasing. It is considered that these facts show that rather than the resin solutions act as an adhesive, they act to swell or dissolve the treated part, thereby rearranging the molecular arrangement of said part, of which crimp has previously been set, and thus disappearing the crimp thereof, while the resin melted in said solution properly controls the dissolving action of the solvent not to be excessive particularly at room temperature.

As examples of recipes for resin solutions which can be used as suitable treating agents in this invention, among those for polyamides there are, for example, 1,000 cc. of methanol, 100 g. of calcium chloride, tin chloride or zinc chloride and 20 g. of waste nylon; 1200 cc. of formic acid, 750 cc. of water and 150 g. of waste nylon; 1200 cc. of phenol, 1200 cc. of ethylene glycol and 40 g. of waste nylon; and 100 g. of phenol, 900 g. of dichloroethane and 40 g. of waste nylon.

As the resin solutions for polyesters, particularly polyethylene glycol terephthalate, there can be cited, 600 g. of phenol, 400 g. of tetrachloroethane and 20 g. of polyester chips; and 700 g. of trichlorophenol, 1000 g. of phenol and 30 g. of polyester chips. Also as those for polyolefines, especially polypropylene, there is a resin solution comprising 100 g. of dioxane and 10 g. of polypropylene chips. In addition, for acrylonitriles, there can be used 150 g. of sodium thiocyanate, 30 g. of polyethylene oxide, 10 g. of polyacrylonitrile and 810 g. of water; and 40 g. of zinc chloride, 40 g. of polyethylene oxide, 10 g. of polyacrylonitrile and 910 g. of water. Furthermore, a solution consisting of 200 cc. of acetone, 200 cc. of amyl acetate, 20 g. of cellulose acetate flakes, and 10 cc. of octyl phthalate may be used for releasing the crimp of the crimped cellulose acetate filament yarn.

The treating agents to be used in the method of this invention may, in some cases, contain dyestuffs for the filament to be treated, preferably those having an affinity to oils. In this case, the treating agents also act as a dyeing adjuvant, and thereby fortunately the treated part of the yarn is dyed simultaneously with the release of the crimp of said part.

The above treating agents are intermittently applied to a crimped filament yarn which is running, and thus a crimped yarn mottledly applied with a treating agent

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along its longitudinal direction is obtained. There is no limitation as to the means for the continuous application of a treating agent to the travelling crimped yarn. Either an engraved roll or a nozzle for supplying a treatment liquor disposed so as to make an intermittent contact with said travelling yarn may be used. In case of the latter, said nozzle may be vibrated or instead the yarn may be vibrated while the nozzle is fixed. Particularly preferable is a method wherein a forced vibration is imparted by means of a vibrator to the crimped yarn which is continuously running, by which is made intermittent the contact of said yarn to a nozzle for feeding a treatment liquor which is provided within the limit of the amplitude of a vibration given by said vibrator. According to this method, a period of vibration of said yarn can be controlled. Therefore, by the selection of a proper vibrating means, it is possible to easily control the length of time and the intervals of said contact, and also by the control of the running speed of said yarn, the crimped part and the crimp-released part of the yarn may be adjusted to the respective desired length.

As the vibrating means to be used, any means may be properly selected, provided that the means are able to impart a desired period of vibration to the yarn. Optional methods such as, for example, electrical methods, magnetic methods, mechanical methods and/or the combinations thereof may be employed.

The yarn intermittently applied with a treatment liquor is passed under tension through a heating zone, the temperature of which should not be above the softening point or decomposition point of the yarn being treated. Also, it is mainly in a heating zone that the rearrangement of the molecular of the yarn being treated substantially takes place and the release of the crimp is effected as desired. In order to facilitate the molecular rearrangement in a short period of time, it is necessary to make the temperature of the heating zone higher than the second order transition point of thermoplastic resins constituting the yarn, thus the temperature is depended upon the materials to be treated.

As temperatures of the heating zone, the temperatures of about 120–190° C. for 6.6-nylon yarns, about 120–180° C. for 6-nylon yarns, 120–240° C. for polyethylene terephthalate, 120–230° C. for polyacrylonitriles, 110–155° C. for polypropylene and 120–250° C. for cellulose acetate are usually used. When a yarn is running at a higher speed, said temperatures may be made higher. In case lower temperatures than those given above are used, since low temperatures necessitate the yarn to be run at lower speeds in order to attain the desired effect, the use of lower temperatures is not entirely impossible but disadvantageous. No special limitation is imposed on the heating means. Electrical heating, infrared heating, blowing of heated gases or others may be properly selected.

In the method of this invention, it is sufficient for the crimped yarn which has been intermittently applied with a treating agent to be kept under tension while it passes through a heating zone, but if desired, said yarn may be drawn to a certain degree while it is in the heating zone or right after it is discharged out of the zone. Also, the product obtained according to the present invention may be applied with finishings such as washing, drying, dyeing, etc.

The product of the method of this invention is a novel intermittently crimped filament yarn having a crimped part and a crimp-released part alternately along the longitudinal direction thereof. The crimping state of such an intermittently crimped wooly yarn is not affected by laundry as in the case of adhesives being coated on the yarn, and the touch of the yarn is excellent. Also, when said yarn is knit or woven into a fabric, the yarn structure particular to said yarn may produce the marked differences of thickness in the fabric, that is, for

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example, with the use of said yarn, the obtained fabric may possess a surface presenting an exquisite unevenness; when said yarn is used for the knitted goods such as knit wears, a cloth having transparent parts therein may be obtained; and when it is used for knitting socks and the like, the product may present a lacelike appearance. Thus, the intermittently crimped filament yarn of this invention may be used in the new fields of uses which have not been attacked before and effect of this novel yarn is extremely great.

In order to more clearly understand the present invention, the following specific examples are given, it being understood that the examples and drawings given herein are merely intended in an illustrative sense, and the invention should not be limited thereby, and the changes which are feasible for those concerned in this field may be made therein without departing from the scope of invention which is defined in the appended claims.

Example 1

As a starting material, was used a crimped filament yarn prepared by following the steps of strong twisting, heat setting and untwisting a nylon filament yarn which has been obtained by making multifilaments of 110 denier comprising 30 monofilaments into a 2-ply yarn.

As shown in FIG. 3 a yarn was run from a package 31 through a guide roller 32, tension was imparted to said running yarn by means of a tension device 33, vibration was imparted thereto by way of rotating a triangular pillar cam 34 which is in contact with said yarn, the top end 35 of a nozzle for feeding a treatment liquor was disposed so as to come into an intermittent contact with said yarn, then the yarn thus intermittently treated was heat dried upon a wheel heater 36 and thereafter wound up via a guide roller 37.

The treatment liquor was obtained by boiling for 15 minutes 1000 cc. of methanol, 100 g. of calcium chloride and 20 g. of waste nylon yarn in a flask provided with a condenser, thereby completely dissolving the same and thereafter cooling, and the liquor was supplied to a nozzle by means of a pump. The nozzle used herein has an opening at the top end, of which width is 0.5 mm. and length is 20 mm. The rotary speed of the triangular pillar cam was 3000 r.p.m. The surface of the wheel heater was maintained at a temperature of 160–170° C. The yarn was wound around the wheel heater once, and the running speed of the yarn was 180 m./min.

In accordance with this particular example, an intermittently crimped yarn wherein in the natural unstretched state of the yarn a crimped part of about 5.7 mm. in length and a crimp-released part of 10 mm. in length interchangeably appear in the longitudinal direction thereof was obtained. In the tensed state of the yarn, the yarn could be drawn as much as to have about 10 mm. in length of a crimped part and about 10 mm. in length of a crimp-released part alternately.

Example 2

A crimped filament yarn obtained by strongly twisting, heat setting and untwisting under tension a polypropylene yarn of multi-filaments of 200 deniers comprising 50 monofilaments was used as a starting material.

By means of an engraved roller which is rotated at a speed of 1000 r.p.m., a treatment liquor was imparted intermittently to the yarn which is running under tension at a speed of 314 m./min. Said treatment liquor was prepared by dissolving 10 g. of polypropylene chips in 1000 g. of dioxane at a temperature of 80° C. and cooling the mixed liquor. The yarn after being applied with the treatment liquor was passed under tension through a heating zone which extends 1 m. in length and heated at 80° C.

In accordance with the method of this specific example, a polypropylene filament yarn intermittently crimped was obtained.

The engraved roller used in this method possesses a convexed part and a concaved part with respective length of 2 mm. and 8 mm. provided in alternation. The running speed of the yarn corresponded with the circular speed of the roller. The obtained product had under tension 8 mm. of a crimped part and 2 mm. of a crimp-released part, and under the relaxed state said crimped part was observed to contract to about 5 mm.

Example 3

As a starting material, there is used a polyethylene terephthalate ester yarn of 50 deniers multifilament composed of 50 monofilaments that is obtained by subjecting it to strong twisting, heat setting, untwisting, strong twisting in a reverse direction, heat setting again, untwisting and final heat setting.

Said yarn was run under tension at a speed of 100 m./min., made to contact with a vibrating plate, which vibration effecting a forced vibration on said yarn, and thus the yarn came to an intermittent contact with a nozzle for feeding a treatment liquor. The nozzle used in this example was similar to that used in Example 1. The treatment liquor was prepared by dissolving 20 g. of polyethylene terephthalate waste yarn in 600 g. of phenol and 400 g. of tetrachloroethane. The yarn thus intermittently applied with said treatment liquor was under tension passed through a heating zone of 1 m. by length heated at 150° C.

According to the above method, a mottledly crimped filament yarn of polyethylene terephthalate was obtained.

The thus obtained intermittently crimped filament yarn had, in its tensed state, 5 mm. of a crimped part and 1 mm. of a crimp-released part, and in its relaxed state said crimped part was observed to contract to about 3 mm.

Example 4

The filaments of cellulose acetate of 300 deniers were made into 3 ply, twisted, heat set and untwisted. The thus obtained crimped yarn was intermittently applied with a treatment liquor which was prepared by dissolving 20 g. of cellulose acetate flakes into 200 cc. of acetone and admixing thereto 200 cc. of amyl acetate and 10 cc. of octyl phthalate. The yarn applied with the treatment liquor was heated at 150° C. under tension.

In this method, an intermittently crimped filament yarn of cellulose acetate was obtained. The method for applying the treatment liquor was the same as in Example 1. The width of a nozzle was 0.3 mm., the running speed was 200 m./min., and a rotary body having six arms was used and rotated at a speed of 3000 r.p.m.

The intermittently crimped yarn thus obtained had, in its tension, 5 mm. of a crimped part and 2 mm. of a crimp-released part, and in its relaxation said crimped part was observed to contract to approximately 3 mm.

Example 5

Substantially the same method as in Example 1 was practiced except that a crimped yarn obtained by false twisting and heat setting nylon multifilaments of 200 de-

niers was used as a starting material, a solution obtained from 1200 cc. of phenol, 1200 cc. of ethylene glycol and 40 g. of nylon waste was used as a treatment liquor, and the running yarn was imparted a forced vibration by means of an electro-magnetic means. The product thus obtained was an intermittently crimped filament yarn of nylon.

What is claimed is:

1. A method for producing an intermittently crimped multi-filament yarn which is characterized by steps of continuously running under tension a crimped multi-filament yarn formed of a thermoplastic resin, intermittently applying to said yarn along its longitudinal direction a treatment liquor containing a compound capable of manifesting at least a swelling action in said thermoplastic filaments, passing the thus-treated yarn under tension through a heating zone, and thereby releasing the crimp in the treated part of said yarn.

2. A method for producing an intermittently crimped filament yarn which comprises continuously running under tension a crimped multi-filament yarn formed of a thermoplastic resin, intermittently treating said crimped filament yarn along its longitudinal direction with a treatment liquor comprised of said thermoplastic resin dissolved in solution of up to about 5% by weight, passing the thus treated yarn under tension through a heating zone, and thereby releasing the crimp in the treated part of said yarn.

3. The method according to claim 1 in which said treatment liquor contains a dye.

4. The method according to claim 2 in which said treatment liquor contains a dye.

5. The method according to claim 1 wherein said running yarn is vibrated by means of a vibrator and said treatment liquor is fed from a nozzle in the amplitude of said vibrating yarn so that contact of said yarn with the liquor is intermittent.

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