

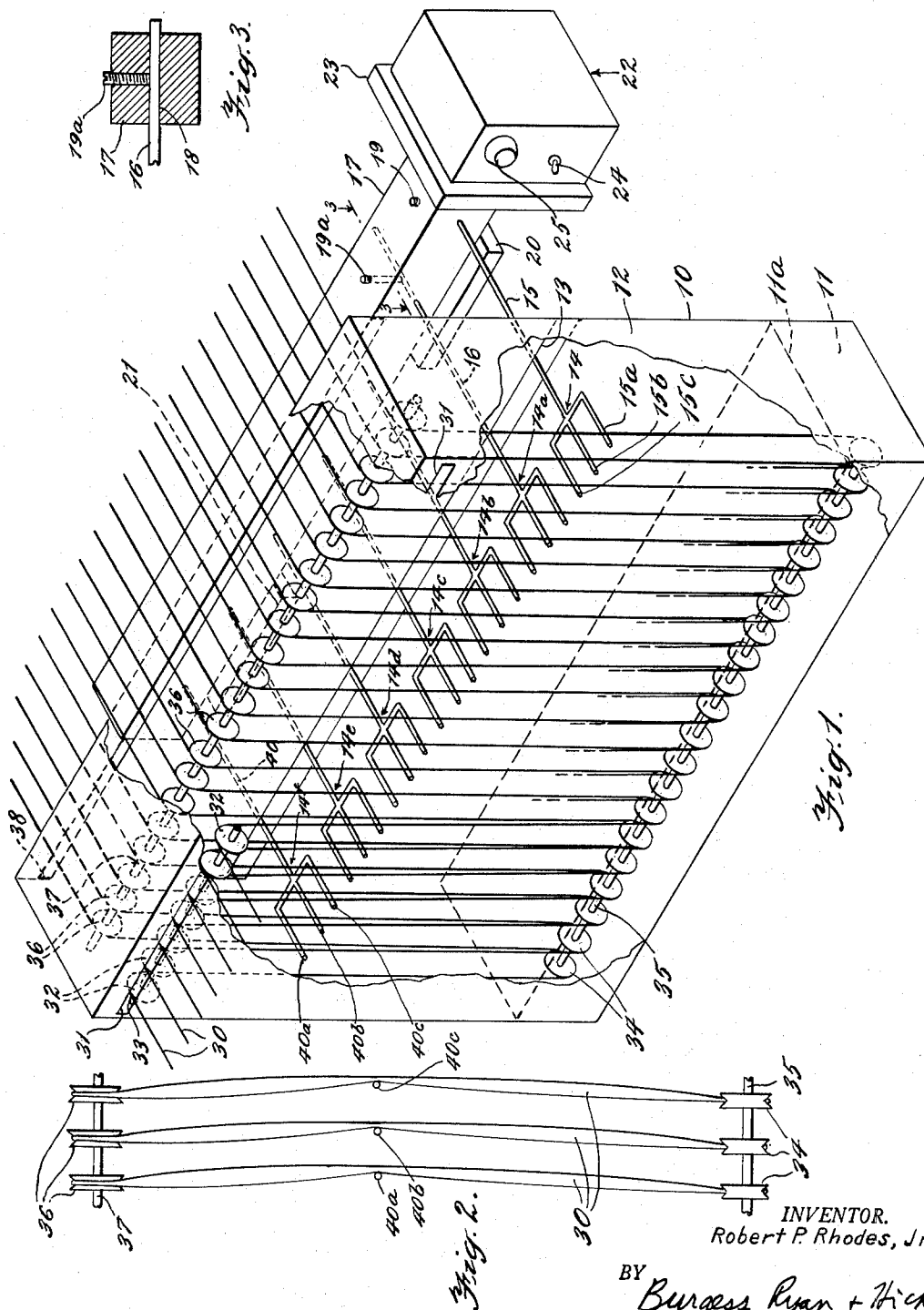
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R. P. RHODES, JR

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APPARATUS AND METHOD FOR VIBRATING FILAMENTOUS MATERIALS

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INVENTOR.
Robert P. Rhodes, Jr.

BY
Burgess, Ryan + Hicks
ATTORNEYS

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APPARATUS AND METHOD FOR VIBRATING FILAMENTOUS MATERIALS

Robert P. Rhodes, Jr., Pittsburgh, Pa., assignor to Coats
& Clark Inc., a corporation of Delaware

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This invention relates to a method and apparatus for treating filamentous or fibrous material with a treating agent wherein the amount of agent added to the filamentous material is closely controlled and evenly distributed on the material. More particularly, the invention comprises treating individual ends of filamentous material, such as thread and yarn, with a desired agent, and then shaking the individual ends by vibrating them to remove excess agent. The invention is useful, for example, in bonding thread or yarn, wherein the constituent filaments of the thread or yarn are bonded to one another and an enveloping coat deposited about them, using any suitable bonding agent. Polishing or sizing, liquid waxing operations, sizing of rubber cotton yarns, etc. may be carried out, as well as other operations in which it is desired to control the amount of agent deposited on filamentous material.

It has been found that by vibrating the individual ends during and after the treating step, as described herein, it is possible to control accurately the amount of agent or "add-on" material which is deposited on the ends, to improve the distribution of such agent on the ends, and to effect these results without adding appreciable tension to the ends. This last effect is important in the treatment of individual ends, especially low denier threads and yarns which tend to break very easily, and is in contrast to prior practices in which treated thread and yarn are passed through wicks, which wipe off excess agent, or over squeeze rolls, which wring out the excess, or subjected to other operations to remove excess agent, which devices and practices result in an appreciable incidence of breakage due to tension.

The invention may be better understood by referring to the accompanying drawing, in which a selected embodiment is shown diagrammatically and in which:

Fig. 1 is a broken away, perspective view of a form of apparatus and method for carrying out the invention;

Fig. 2 is a view of a portion of the apparatus of Fig. 1, showing several ends being vibrated; and

Fig. 3 is a section on the line 3-3 of Fig. 1.

The apparatus comprises a vessel 10 for holding a bath 11 of treating agent. The walls 12 of the vessel extend well above the level 11a of the bath. Vibratable members 14-14f extend into the vessel through a slot 13 in one side and are spaced from the level of the bath. The member 14 is fork-shaped and comprises a handle 15 to which is connected a plurality of fork tines 15a-15c. Members 14a-14f have a similar construction. Each member or fork is connected to a vibration transmitting member 17 in the manner shown in Fig. 3, wherein handle 16 of member 14a is arranged in a bore 18 in the member 17 and is retained therein by means such as the set screw 19a. Member 17 may be supported by any desirable means, not shown, and it is preferred to interpose between such support means and member 17 some sort of vibration absorbing means such as the rubber pads 20, 21. One end of member 17 is connected to vibrating means 22, shown here in the form of an electromagnetic vibrator having a vibratable deck 23 to which the member 17 may be suitably attached. The vibrator is equipped with an operating switch 24 and a rheostat knob 25 for controlling the amplitude of vibration of the deck and the various members connected thereto.

Spaced individual ends 30 of filamentous material from a source not shown enter the vessel 10 through a longitudinal opening 31 and are moved downwardly into the

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vessel, passing over the pulleys 32 mounted on the pulley shaft 33. The ends pass into the bath, then around the pulleys 34 which are immersed in the bath and supported on the shaft 35, then upwardly through and out of the bath. Each end next passes by a fork tine with which it makes contact, then travels over a pulley support 36 mounted on the shaft 37, and finally leaves the vessel through a longitudinal opening 38. The ends are drawn into, through, and out of the bath and vessel by conventional means not shown.

During the movement of the ends through the bath, the operation of vibrator 22 is started, and the vibrations thus set up in member 17 are in turn imparted to the members 14-14f. As will be appreciated, the amplitude through which the tines of members 14-14f vibrate will be much greater than the amplitude of member 17 or deck 23. The position of the members 14-14f relative to the ends is such that each end bears slightly upon its corresponding tine, as may be apparent from Fig. 2, the purpose being to maintain each end in contact with its tine at all times during the vibration of the ends. The amount of tension set up in the ends in this way is slight.

As will be apparent from Fig. 2, the vibrating fork tines shake the ends and cause them to vibrate, a vibration wave being formed by each end. This wave extends from a point or node below the bath level, i. e., at the pulleys 34, to the pulley supports 36, which may also be regarded as nodes, with nodes being formed intermittently at points near the contact of the end with its fork tine. The vibratory motion thus set up in the ends aids the bath agent to become more evenly distributed on the ends and effectively serves to remove excess agent. These effects, it may be noted, result from the mechanical shaking caused by the vibrational waves. If necessary, tension may be added to material capable of absorbing it to aid in obtaining an effective wave. Tension may be increased by attaching any well known tensioning device, such as a drag, to the pulleys 32 and/or 34, or to one or other or both of the shafts upon which these pulleys are mounted. For some very weak filamentous materials the addition of such tension, or pre-tension, may not be advisable but with material of sufficient strength the use of this pre-tension will increase the effectiveness of the vibrations.

In the treatment of any given filamentous material, it has been found possible to position the vibratable members 14-14f at such a distance from the level of the bath that the pulley supports 36 are maintained substantially free from carry-over of the treating agent. There is thus no opportunity for agent to collect on the pulleys and pass back to the ends. This position of the vibratable members, it may be noted, is somewhat variable, but it should not be so far from the bath level as to interfere with the removal of add-on, and preferably it should not be so close to the bath level as to cause the vibrating ends to form cones of bath agent which may disturb the otherwise smooth operation of the process. By operating in this way, i. e., by preventing agent carry-over from reaching the pulley supports, a control may be exercised over the process to insure that the treatment of the ends with agent and the distribution and removal of excess agent is proceeding satisfactorily.

The form of apparatus shown in the drawings is useful for simultaneously processing a large number of individual ends, and as will be appreciated, it can be equipped with additional vibratable members like 14-14f so as to process an even larger number of ends. It is also possible to employ only one vibratable member, and this may have the form of a multi-tined fork, as shown, or simply a rod or rod-like member not equipped with tines. In one experiment, two of such rods were employed, each of which was independently connected to the deck of an electromagnetic vibrator of the kind described. The rods were made of 1/8-inch stainless steel stock, were each

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about 6 inches long and spaced about $\frac{1}{2}$ inch apart. Two ends of 70 denier nylon yarn were processed with this arrangement, the yarns first being treated with an alcohol-soluble nylon bonding solution and then brought into contact with and vibrated by the rods. The ends were passed down through a 20-inch depth of solution and back out, then past the rods at a speed of approximately 105 ft./min. for a period of one half hour while the rods were vibrated at a frequency of 3600 cycles per minute. The rods were spaced about 4 to 8 inches from the bath level. The pulley supports traversed by the ends after leaving the rods remained substantially dry throughout the run. In a second experiment, a vibratable member such as shown at 14 in Fig. 1, comprising a fork having three tines, was employed. This fork was made of $\frac{1}{8}$ -inch stainless steel and had tines one inch long and a half-inch apart, and a handle $6\frac{1}{2}$ inches long. Three ends of 70 denier nylon yarn were processed with the same solution as in the first experiment, but having a depth of about 8 inches over a period of three hours at a yarn speed of about 90 ft./min., using a vibrating frequency of 3600 cycles per minute. The tines were spaced about 4 to 8 inches from the solution level. The tension on each end in this experiment did not exceed 35 grams per end, which is well below the amount required to break the yarn. The bonded yarn products of both these experiments were smooth to the touch, and had very good bond strength and general appearance. Sewing tests demonstrated that they were very good from the standpoint of sewability. Microscopic examination of the yarns, both longitudinally and in cross section, showed them to have a relatively heavy coating of bonding material uniformly applied along the yarn and good interfilament penetration by the bonding material. The yarns were superior in these respects to yarns processed by squeeze rolls for removing excess solution.

Besides an electromagnetic vibrator, other types of vibrators may be used, such as rotary or hydraulic devices. Irrespective of the kind of vibrator employed, it will be seen that the ends are vibrated mechanically by the member 14—14f, although the latter may be vibrated by different means. Any filamentous or fibrous material capable of being treated with conventional agents and vibrated as described may be processed according to the invention. Nylon, cotton, wool, glass, protein, cellulosic, rayon, and other synthetic fibers may be treated. Because of the low tension to which the fibers are subjected during treatment, the invention is particularly advantageous for threads and yarns of low denier, say below about 70 denier. As indicated, conventional agents such as bonding solutions, polishing and sizing agents, liquid wax or other thread finish or any other type of material capable of being added to fibrous strands, such as thread or yarn, in liquid or powder form may be used with the invention. The principles of the invention are also applicable in cases where thread, yarn, or other material must be agitated during treatment, particularly when the treating agents are solutions having high viscosities.

The amount of add-on agent may be closely controlled by vibrating the ends at a selected frequency and amplitude. Different frequencies may be employed by using vibrators of different frequencies, or if the vibrator is adjustable to deliver varying frequencies, it may be so adjusted. The amplitude of vibration may be varied by adjusting the rheostat knob 25 which regulates the voltage to the vibrator. Generally, low frequencies and amplitudes will leave more add-on agent on the ends than high frequencies and amplitudes. For many applications, the range may be from 1000 to 10,000 cycles per minute, and the range of amplitudes from about $\frac{1}{8}$ to about $\frac{1}{2}$ inch, although these limits may be extended in certain cases. In a given case, the operator will decide, or be told, how much add-on is to be left on the ends, and he can then select the frequency most effective or appro-

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priate for the purpose. This frequency may, of course, be determined beforehand empirically. The length of the vibratable member or members will then be adjusted so that the member will vibrate at the chosen frequency. Then by adjusting the amplitude of vibration and correctly positioning the vibratable members relatively to the bath level and the pulley supports 36, the ends can be effectively vibrated to obtain the desired amount of add-on. Control over the amount of add-on may also be secured, at least to some extent, by varying the time during which the ends are vibrated, or in other words, the speed of the ends through the bath.

The vibratable members may be of any suitable material and size provided they are capable of vibrating at the desired frequency. Where forks such as 14 are employed, the length of the fork tines 15a—15c should be properly selected, for if the length is too short, there is difficulty in keeping the ends in contact with the tines, and if it is too long, the vibrations of the ends may be disturbed. The distance between the tines should be large enough to prevent the ends from making contact with each other, and should be greater than the maximum amplitude required, but not so large as to require an excessive amount of space. Practically speaking, it was found that good results could be obtained by spacing the tines about one-half inch from each other.

As described, the tension imposed on the ends by virtue of their contact with the vibratable members is slight. Only that amount of tension necessary to hold the ends in contact with the members is employed, and in fact, a substantial part of this tension is provided by the weight of the treating agent on the ends, especially when the agent is a liquid. Generally speaking, the amount of tension employed is only a small fraction, say about 5%, of the amount required to break the ends. By preventing loss of contact between the ends and the vibratable members, a smoother and gentler vibrating action is obtained. It may also be noted that the contact time of the ends in the bath agent is at least long enough to permit the agent to add on to the ends. Depending on the agent and on the ends being treated, the contact time is variable, but in general the speed of the ends through the bath is substantial, enabling a good production rate to be sustained. The depth of the bath in the vessel 10 will depend on the contact time or speed, and preferably a minimum depth is used. Even with a minimum depth, the invention makes it possible to vibrate the ends while they are underneath the surface of the bath, and this step effectively wipes away the stagnant layer which, especially in the case of liquids, clings to the fibers, and promotes a greater rate of reaction, or interaction, between the treating agent and the fibers.

Although the invention has been described and illustrated in connection with certain selected embodiments of the same, it will be understood that it is capable of obvious variations without departing from its scope.

In the light of the foregoing description, the following is claimed:

1. In apparatus for treating lengths of thread or yarn with liquid agent and for controlling the amount of agent added to said lengths, a vessel for holding a bath of said agent having walls extending above the level of the bath, a plurality of vibratable members extending into the vessel and spaced from said bath, guide means for introducing a plurality of spaced individual lengths into said bath to treat the same, means in said vessel adapted to be submerged in the bath for assisting in passing each length out of the bath and then upwardly and in contact with one of said vibratable members, a support above each vibratable member for receiving the length therefrom, a common handle to which said members are attached extending to one side of said vessel, a vibration transmitting member to which said handle is connected, vibrating means for vibrating said transmitting member and thus said handle and vibratable members, adjustable connecting means

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adapted to hold the handle to said transmitting member and to enable the length of the handle to be varied, thereby enabling the latter to vibrate at various frequencies and through various amplitudes, said handle and vibratable members having the resonant frequency of said vibrating means.

2. In apparatus for treating lengths of thread or yarn with liquid agent and for controlling the amount of agent added on to said length, a vessel for holding a bath of said agent having walls extending above the level of the bath, a plurality of vibratable forks extending into the vessel and spaced from said bath, each fork having a plurality of tines, guide means for introducing a plurality of spaced individual lengths into said bath to treat the same, means in said vessel adapted to be submerged in the bath for assisting in passing each length out of the bath and then upwardly and in contact with one of said fork tines, a support above each fork tine for receiving the length therefrom, a vibration transmitting member to which said forks are connected, electromagnetic vibrating means for vibrating said transmitting member and thus said forks and fork tines, adjustable connecting means adapted to hold each fork to said transmitting member and to enable the length of the fork to be varied, thereby enabling the fork tines to vibrate at various frequencies and through various amplitudes, said forks having the resonant frequency of said vibrating means.

3. In apparatus for treating lengths of thread or yarn with a treating agent and for controlling the amount of agent added on to said lengths, a vessel for holding a bath of said agent, a plurality of vibratable members extending into the vessel and spaced from said bath, guide means for introducing a plurality of spaced individual lengths of thread or yarn into said bath, means in said vessel adapted to be submerged in the bath for assisting in passing each length out of the bath and in contact with one of said vibratable members, a support above each vibratable member for receiving the length therefrom, a member engageable by the vibratable members for mechanically moving and thus vibrating the latter, vibrating means for vibrating said engageable member, each said length being adapted to be vibrated to form a vibrational wave between said submerged means and said support, and said vibratable members having the resonant frequency of said vibrating means.

4. In apparatus for treating an individual length of thread or yarn with a treating agent and for controlling the amount of agent added to said length, a vessel for holding said agent, a vibratable member extending into the vessel and spaced from said agent, guide means for bringing said length into contact with said agent, means in said vessel adapted to be submerged in the agent for assisting in passing said length in contact with said vibratable member, a support spaced from said vibratable member for receiving the length therefrom, a vibration transmitting member to which said vibratable member is connected, vibrating means for vibrating said transmitting member and thus said vibratable member, adjustable connecting means adapted to hold said vibratable member to said transmitting member and to enable the length of the vibratable member to be varied, thereby enabling the latter to vibrate at various frequencies and through various amplitudes, said vibratable member having the resonant frequency of said vibrating means.

5. A method for treating lengths of thread or yarn of substantially low denier with liquid agent and for closely controlling the amount of such agent added on to said lengths which comprises passing a plurality of spaced lengths into and through a bath of said agent, said lengths being out of contact with one another, passing each length upwardly as it leaves the bath to a spaced point, vibrating the treated, spaced lengths at a point intermediate the bath and said spaced point so that each length forms a vibrational wave extending from a low point below the bath level to said spaced point with a

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node of the wave at said intermediate point, thus aiding the distribution of the liquid agent on said lengths and removing excess agent, coincidentally supporting each length at said intermediate point while vibrating the same, vibrating said lengths at such a height above the level of the bath and at such a frequency and amplitude that each said spaced point is substantially free from liquid agent carry-over, and holding said lengths under sufficient tension to aid in supporting the lengths at said intermediate point during vibration, said tension not amounting to more than a small fraction of that necessary to break the lengths.

6. A method for treating lengths of thread or yarns with liquid agent and for closely controlling the amount of such agent added on to said lengths, said lengths being spaced from one another, which comprises passing a plurality of spaced lengths into and through a bath of said agent, passing each length as it leaves the bath to a spaced point, vibrating the treated spaced lengths at a point intermediate the bath and said spaced point so that each length forms a vibrational wave extending from a low point below the bath level to said spaced point with a node of the wave at said intermediate point, thus aiding the distribution of the liquid agent on said lengths and removing excess agent, coincidentally supporting each length at said intermediate point while vibrating the same, vibrating said lengths at such a height above the level of the bath and at such a frequency and amplitude that said spaced point is substantially free from liquid agent carry-over.

7. A method for treating lengths of thread or yarn with treating agent and for closely controlling the amount of such agent added on to said lengths, said lengths being spaced from one another, which comprises passing a plurality of spaced lengths into and through a bath of said agent, passing each length to a spaced point, vibrating the spaced lengths at a point intermediate the bath and said spaced point so that each length forms a vibrational wave extending from a point below the bath level to said spaced point with a node of the wave at said intermediate point, thus aiding the distribution of the agent on said lengths and removing excess agent, coincidentally supporting each length at said intermediate point while vibrating the same, and holding said lengths under sufficient tension to aid in supporting the lengths at said intermediate point during vibration, said tension not amounting to more than a small fraction of that necessary to break the lengths.

8. A method for treating a length of thread or yarn with a treating agent and for closely controlling the amount of such agent added on to said length which comprises passing the length into contact with said treating agent, then passing the length to a spaced point, vibrating the treated length at a point intermediate said contact step and said spaced point, thus aiding the distribution of the agent on the length and removing excess agent, coincidentally supporting said length at said intermediate point while vibrating the same, vibrating said length at a frequency and amplitude so as to prevent agent carry-over from collecting at said spaced point, and holding said length under sufficient tension to aid in supporting the length at said intermediate point during vibration, said tension not amounting to more than a small fraction of that necessary to break the length.

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