

July 23, 1963

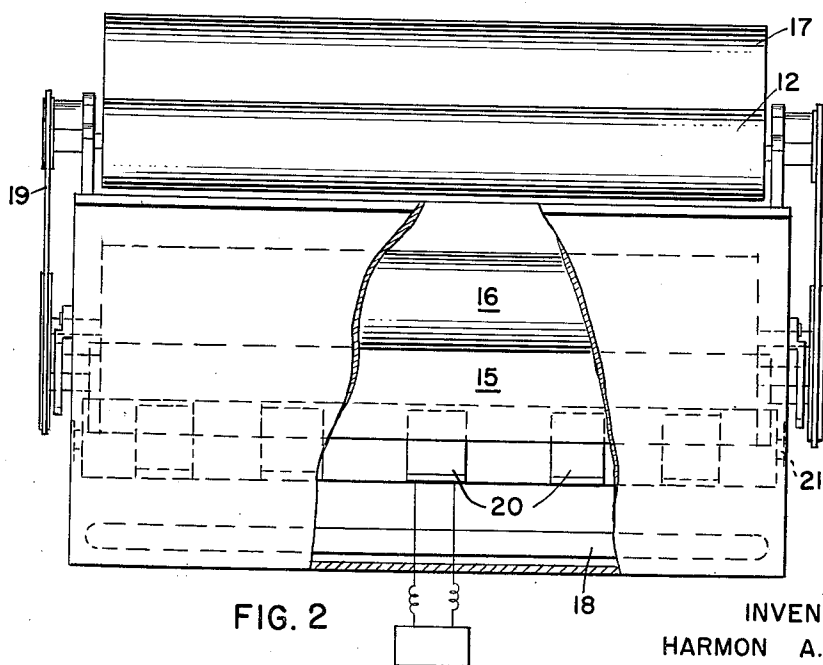
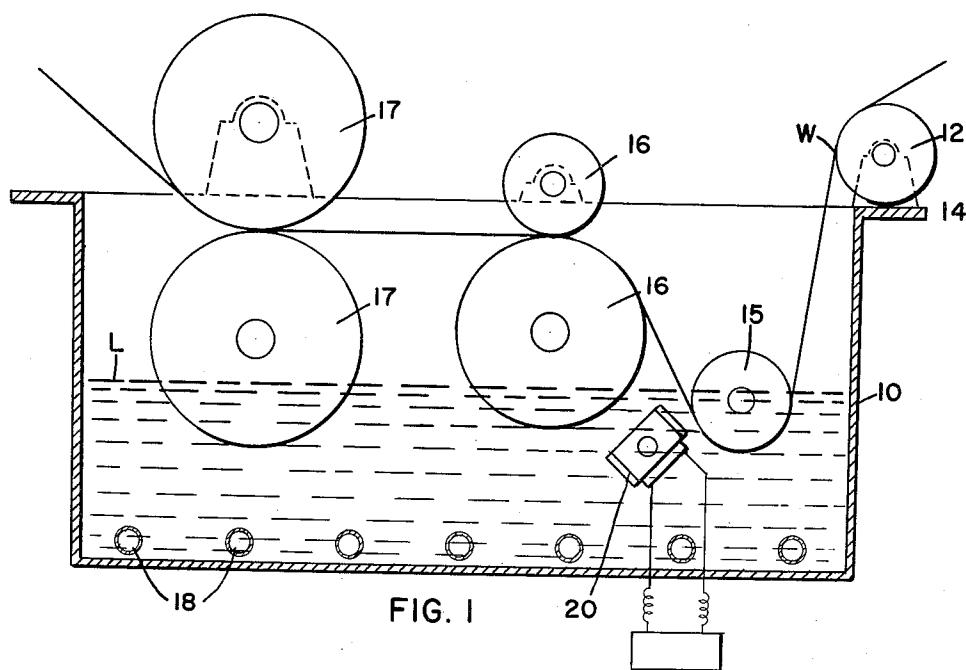
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3,098,370

TREATMENT OF LIQUID IMMersed MATERIAL

Filed Aug. 17, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

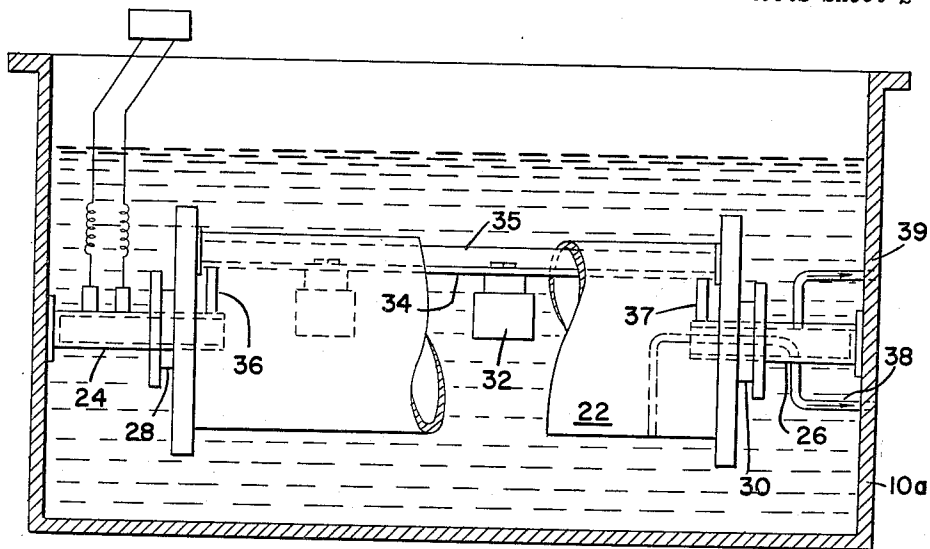


FIG. 3

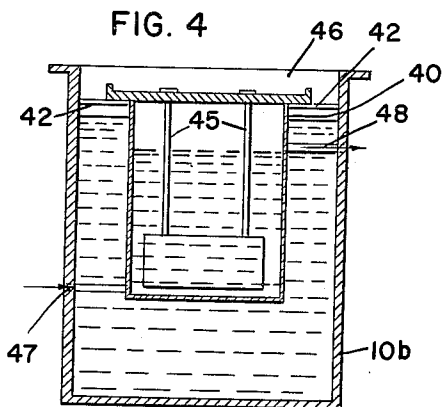


FIG. 4

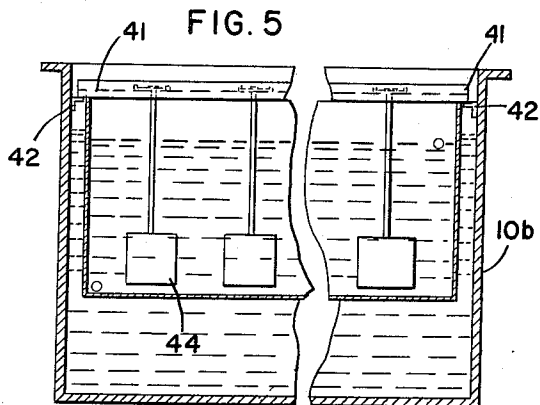


FIG. 5

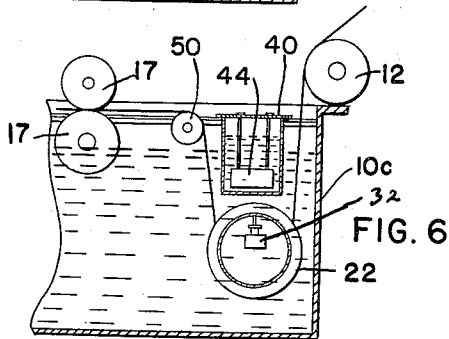


FIG. 6

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TREATMENT OF LIQUID IMMersed MATERIAL
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 5 Claims. (Cl. 68—3)

The present invention relates to new and useful improvements in a method and apparatus for treating material in various forms, such as in the form of fibers, filaments, yarns and fabrics, strands and other elements formed therefrom, and more particularly to such improvements in the method and apparatus for increasing impregnation of the material by a treating liquid in which the material is immersed at least to the extent of intimate contact therewith.

The principal object of the present invention is to increase impregnation of the material with the liquid and to also cause more intimate association of the liquid with the interstices of the material by sonic or ultrasonic irradiation into the treating medium and material.

The fibers, filaments and yarns may be en-masse, spun, twisted, plied or the like and the material formed therefrom may be woven, knitted, braided, matted, felted or laid, and in the woven form, it is intended to include the plain and fancy woven forms including laces, and a further application is in leather tanning.

In speaking of a treating liquid, this is intended to include a true solution as well as mixtures and suspensions, and also viscous liquids. In speaking of sonic or ultrasonic irradiation which is frequently used in the trade, it is intended to indicate sonic or ultrasonic vibrations which are imparted to the treating liquid.

In the treatment of fibers, filaments, yarns and materials woven, knitted, braided, matted, felted or laid therefrom, there are certain more or less conventional practices as for example, in the sizing, boiling-off, washing, bleaching, dyeing, impregnating, mercerizing, and coating, it is generally standard practice to pass the yarns, filaments, fibers, etc., and fabrics in open width or rope form through a suitable bath, the composition or ingredients of which will have been selected as suitable for the particular operation to be performed, or to impart desired characteristics or quality to the material.

As an example, reference is made to warp sizing or slashing for the purpose of increasing the strength of the warp yarns, as well as to reduce their loss of strength through abrasion, and conventional process contemplate the passing of such yarns beneath an immersion roller within a sizing bath, the usual major component of which is starch, and thereafter passing the yarns successively between squeeze rolls which remove the excess of sizing liquid from the yarns and then the yarns are treated for removing excess moisture to a desired residual content. It is important to strengthen these warp yarns because of the constant motion and friction under tension to which these yarns are subjected in a subsequent weaving operation. The warp sizing is for this purpose in an effort to reduce yarn breakage and, therefore, loom shutdown. Any shutdown of the loom, of course, reduces its productivity but additionally the broken yarn must be knotted and this results in the ultimate fabric being of lowered quality. Also, inspection operations must be expended in an effort to trim such knotted yarns to reduce the objectionable appearance. A small percentage increase in the operating time of a loom is one of the most productive results desired in weaving mill operation. Further, the difficulties from warp yarn breakage increase with the fineness of the yarn and there is a modern trend toward lighter and shearer fabrics.

It is an object of all such sizing operations to force the

2

sizing material into the individual yarns and between the fibers and filaments comprising the same so as completely to surround the individual fibers and/or filaments, but presently existing practices developed over many years of practical mill experience fall far short of the desires of the weaving mills. Therefore, another object of the present invention is to overcome the difficulties mentioned above by improving the penetration and intimate association of sizing liquids with the fibers or filaments and to accomplish the above results by subjecting the sizing liquid to sonic or ultrasonic irradiation or vibrations in the vicinity of the warp as it travels through the sizing bath. Generally similar procedure is followed in boiling off materials in alkaline solutions, soaps, etc., to prepare the material for subsequent bleaching, dyeing and finishing and the present invention is applicable thereto.

As another example, mention is made of the vat dyeing process for open width fabrics. This process, in one conventional form, includes a first stage in which a pigmented coloring material carried by a suitable vehicle is gotten into the fabric by immersion in the liquid, and a subsequent squeezing. There then follows a second stage in which the pigment is reduced to what is commonly spoken of as the leuco state, and then a third step in which the leuco state material is deposited in permanent dye form into the yarns of the fabric by fixing. It has generally been difficult to get a sufficient amount of color on to the fabric and into and between the fibers and/or filaments thereof in a reasonable length of time and the present invention, utilizing sonic or ultrasonic irradiation or vibrations in the liquid, speeds the penetration thereof into the material, in all three of the aforesaid stages.

Another example in which this invention finds useful application is in connection with modern so-called hydrophobic fibers which are, as a class, difficult to dye not only to deep shades but also in the fastness of the shade. These fibers or filaments are frequently dyed in package form as yarns, or in woven or knitted form as rope because conventional methods, common with the non-hydrophobic fibers, are relatively slow and because the dyestuff is reluctantly accepted by the material.

As another example, mention is made of the treatment of sporting and commercial fishing lines. These lines are traditionally made in braided form. To increase serviceability and utility of these lines, dressings are applied by various means but always with the intent to saturate completely the interior of the braided line. Conventional methods have generally proven to be inadequate with the result that there is often excessive exterior coating but an insufficient amount of the dressing material in the interior of the braid where its presence is most desired in that breaking of the outer coating will leave the usual untreated interior of the braid subject to rapid deterioration and breakage. In certain uses, as in casting, a line with a broken surface coating threads itself or flows with difficulty through the line guides; thus its utility is materially reduced. According to the present invention, the application of sonic or ultrasonic irradiation or vibrations to these impregnating or dressing solutions greatly increases and improves the penetration effects of the dressing to the interior of the braid.

In bleaching operations for improved whiteness, fibers, yarns, fabrics, etc., are commonly treated with chemicals for this purpose and the chemical activity is hastened and made more thorough, according to the present invention, by the application of sonic or ultrasonic irradiation or vibrations, which by their action more rapidly replace exhausted ions in the liquid in immediate juxtaposition to the fibers, filaments, yarns, fabrics and the like.

The above illustrations have been given by way of example of the uses to which the present invention may be

put and this invention also provides a method and apparatus for such treatment of the materials which method and apparatus are relatively simple in operation and which lend themselves to ready conversion of existing apparatus for the purposes outlined.

The above and various objects of the invention will impart the obvious and will be hereinafter more fully pointed out.

In the accompanying drawings:

FIG. 1 is a side section, somewhat schematic, showing a size tank through which warp yarns are passed for sizing and showing the transducer means immersed in the size liquid;

FIG. 2 is an end view of FIG. 1;

FIG. 3 is an end section of a size tank or similar treating liquid holding tank with the immersion or other type roller equipped with transducers disposed internally thereof, this being a modification of the transducer arrangement of FIG. 1;

FIGS. 4 and 5 are end and side sections of a treating liquid holding tank having a further modified form of transducer mounting in the form of a separate tank for the transducers; and

FIG. 6 is a side fragmentary section, more or less diagrammatic, showing substantially the same type of size tank as in FIG. 1, but showing the manner in which the transducer mountings of FIGS. 3 and 4 may be associated therewith.

Referring more in detail to the accompanying drawings, and particularly to FIGS. 1 and 2 at this time, there is shown in these figures, for purposes of example, a sizing tank 10 having a size liquid therein up to substantially level L. This sizing tank is of a type generally used for warp sizing but with minor variations may be employed for treatment of various types of fibers, filaments or fabric involving immersion within the treating liquid and with or without subsequent squeezing or the like. As illustrated, warp yarns W are fed over a roll 12 suitably mounted either fixedly or for adjustment by brackets or the like on a flange 14 of the tank 10. The warp yarns are then immersed in the sizing liquid by passage there-through under immersion roll 15 which may be conventionally mounted for adjustment and then the warp yarns are passed through squeeze rolls 16, 16a and then between squeeze rolls 17, 17a and ultimately to a drier (not shown) to reduce the moisture to a desired residual content. The sizing liquid may if desired be heated by steam heating coils 18 or the like arranged interiorly across the bottom of the tank 10. The rolls may or may not be driven, or certain of the rolls may be driven in any suitable manner as by belts 19, gearing or the like.

In the application of sonic or ultrasonic irradiation or vibrations to liquids, it has usually been necessary to isolate the transducer or oscillator from the liquid being activated by an electrically non-conductive intermediate liquid. However, it is preferred to use transducers which are directly immersible in electrically conductive liquids which may be acid, alkaline, corrosive or not, and organic or inorganic without destructive or harmful results to the transducer. Such transducers are commercially available and may be of several types including a magneto-strictive transducer or a transducer of the barium titanate crystal type which latter is hermetically sealed and encased in stainless steel and acoustically but not electrically bonded to the encasement. A transducer is designated by the numeral 20 and is immersed in the sizing liquid and arranged in close proximity to the traveling warp or other material passing under the immersion roll 15, thus to directly irradiate or impart vibrations to the liquid and effect deep and rapid impregnation of the liquid into the interior of the material and to thus provide intimate association of the liquid with the minute fibers and/or filaments and interstices therein. Generally speaking, there will be a number of transducers disposed adjacent one another across the width of the treatment tank and the

spacing of the individual transducers may be varied as desired, but a typical spacing is shown in FIG. 2. The transducers may be supported interiorly of the tank by studs 21, or by external supports on the tank. The transducers are connected in suitable manner with a suitable alternating current generator to supply suitable resonant frequency electrical energy to the transducers.

With the apparatus above described, it will be noted that the warp W is passed beneath the immersion roller 15 which is disposed in close proximity to the transducer means 20. Thus, the irradiation or vibrations of the transducer will effect corresponding vibrations of the liquid in contact with the traveling warp and this will result in a thorough impregnation of the warp and the interstices thereof with the sizing liquid. Warp threads treated in this manner are found to have a much greater strength to withstand the tension and constant movement which subjects them to abrasion in subsequent weaving operations.

It has been pointed out above that the same general type of apparatus, with or without the squeeze rolls, might be employed in treating fabrics which are to be passed through a preselected type of liquid in the tank 10. Thus, mercerizing, the bleaching of fabrics, the coating of strands or the like might be accomplished in such or similar apparatus. The transducer means are positioned within the various liquids employed in a vat dyeing process given by way of example hereinabove. While a vat dyeing process was given as an earlier example, other types of dyeing processes may be employed and the fabric may be in open width form or rope form. In continuous dyeing machines where the material is fed through successive tanks of different liquids, the transducer means may be positioned in each of the tanks for the desired effects and likewise the transducer means may be so positioned in other types of dyeing apparatus as in the kettle type wherein the material is arranged in pleats as it is fed through the tank and then drawn upwardly from the liquid; or as in the padder type wherein the material is continuously drawn under an immersion roller through the liquid and accumulated on an exterior roll; or in the jig type wherein the material is directed beneath immersion rollers in the liquid and is wound or unwound from two rolls to effect a reversal of movement of the material through the liquid; and also in package dyeing where the material in so-called package form is positioned around one or more spindles through which the liquid is circulated.

Instead of directly submerging the transducer means 20 in a treating liquid, such transducer means may be mounted within a separate receptacle and reference is made to FIG. 3 of the accompanying drawings wherein the transducer is illustrated as mounted within a receptacle which may, for example, comprise an immersion roll such as the immersion roll 15 described in connection with FIG. 1. In this form of the invention the roll 22 is mounted for rotation on fixed tubular stub assemblies 24, 26 which are suitably and adjustably mounted on the sides of the tank 10a. Stuffing boxes 28, 30 are associated with the supporting stubs 24, 26, respectively, to seal the interior of the roll against the treating liquid in the tank 10a. There may be several transducers 32 arranged longitudinally with varying degrees of spacing along the length of the roll 22 and these transducers 32 are supported on the horizontal flanges 34 of a bar having a vertical rib 35, the bar being suitably secured in fixed position, as by struts 36, 37 mounted on the inner ends of the supporting stub assemblies 24, 26, respectively. Thus, the transducer system is entirely enclosed within the roll 22 and is sealed against the treating liquid in the tank 10a. The roll 22 is filled with a liquid medium so that as a fabric or threads or the like is immersed in the liquid in the tank 10a by passing the same under the roll 22 and the

5

material is fed thereunder, the transducers, located in close proximity, irradiate through the liquid in the roll 22 to the treating liquid with frequencies such as to effect intimate impregnation of the material with the liquid passing thereby. Obviously, the transducers are connected through suitable leads to a source of alternating electrical current.

Where a liquid enclosed transducer of the above type is to be used in a liquid sensitive to variations in temperature, the heat produced by the transducers may be dissipated or rendered substantially constant by circulating the liquid within the roll 22. With an arrangement of this type, by reason of the fact that the liquid circulating within the roll may be a coolant to maintain the temperature of the transducer means below that of the surrounding treating liquid, the transducer means may be employed and immersed in relatively hot liquids (212° F. for example and above), which might tend to damage or affect proper operation of an unenclosed transducer means. Thus, still referring to FIG. 3, there is provided an inlet conduit 38 projecting to the interior of the stub assembly 26, and an outlet conduit 39. Suitable means may be provided for effecting the desired circulation of liquid through the inlet conduit 38 into the roll 22 and thence outwardly through the conduit 39. Sealing of the transducers within the roll 22 and thus being able to utilize a clean circulating liquid, obviates the need for constant cleaning of the transducers and also tends to insure a uniformly intensive field of ultrasonic radiation therethrough.

Another form of liquid enclosed transducer is shown in FIGS. 4 and 5 to which reference is now made. In this form of the invention there is provided a separate receptacle 40 which is mounted, as by flanges 41, on suitable adjustable brackets 42 which may be adjustable and which are secured to the interior of the liquid tank 10b. This receptacle 40 is also sealed against the liquid in the tank 10b and carries its separate liquid within which the transducers 44 are immersed. These transducers may be adjustably supported by drop rods 45 which in turn are supported by transverse carrying beams 46 supported on the upper edges of the receptacle 40 and the leads from a suitable generator may pass through these drop rods 45. Here again, therefore, the transducers may be adjustably positioned adjacent material which may be dipped within the tank 10b, as in dyeing processes, or the material may be passed continuously therethrough. Also, with the receptacle 40, the liquid level there in may be maintained and circulated by providing an inlet conduit 47 and an outlet conduit 48. Suitable means may be provided for effecting the desired circulation of liquid. In this form of the invention, as described in connection with FIG. 3, the transducers will irradiate the liquid confined by the inner receptacle and this irradiation will in turn be transmitted to the exterior liquid.

FIG. 6 is a diagrammatic showing of the manner in which the roller enclosed type transducer of FIG. 3 or the receptacle type transducer of FIGS. 4 and 5 may be positioned. It is to be understood that the showing of FIG. 6 is alternative as to the two types, unless for one reason or another, both types or more than one transducer assembly may be desired for more intensive irradiation or for imparting irradiation to a more extended surface of the material under treatment. The type of tank shown in FIG. 6 is a fragmentary showing intended to indicate various types of treating tanks, depending upon the operation being performed. For illustration, the roll 22 housing the transducer means may constitute the immersion roll of a sizing tank such as that shown in FIG. 1. On the other hand, the use of the transducer means and separate receptacle 40 positioned between the two runs of the material being treated, may constitute the irradiation or vibration means

6

for various types of tanks depending upon the treatment to be imparted to the material. In positioning the transducer receptacle 40 in a tank between two runs of material being treated, it may be desirable to arrange an additional guide roller 50 positioned in such relation to an immersion or other type roller as to make the two runs of the material substantially equidistantly spaced on opposite sides of the receptacle 40 and relatively close to the transducer means therein. In this manner, both runs of the material may be subjected to the irradiation or vibrations from the transducer means, thus to increase the effectiveness thereof. It is, of course, also to be understood that the above described arrangement of the transducer means between both runs of the material being treated is applicable not only to the receptacle type of transducer but also to the type of transducer shown in FIG. 1. In other words, the transducer means of FIG. 1 may be positioned equidistantly between two runs of the material being passed under an immersion roller or the like.

This invention has been described with respect to certain types of apparatus and with mention of various examples of treatment to which the method and apparatus may be applied. The several examples, as uses, are mentioned by way of example and not by way of limitation. It is difficult to indicate the precise range of frequencies at which the transducers may be operated since the vibrations may range in cycles per second from below audible through sonic and ultrasonic irradiation of varying frequencies. Satisfactory results have been obtained with frequencies ranging from 5,000 to 30,000 cycles per second but other frequencies, as for instance between 1,000 cycles per second to 60,000 cycles per second, above or below, would from experience be serviceable in various operations.

While certain forms of the invention and methods of applying the same to various treating liquids have been described or shown for purposes of illustration, it is to be clearly understood that various changes in details of construction and manner of use may be employed without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. Apparatus for treating materials in the form of filaments, fibers, yarns and fabrics, strands and other elements formed therefrom; and comprising a tank for holding a treating liquid of predetermined composition selected to impart desired characteristics and quality to the material, an immersion roller containing a separate confining liquid isolated from the treating liquid and at least partially submerged in the treating liquid, means for directing the material through the treating liquid in said tank and in contact with the immersed surface of said roller, and transducer means separately immersed in the confining liquid in said roller and disposed in close proximity to the material in the treating liquid for imparting sonic through ultrasonic vibrations effective to increase impregnation and intimate association of the treating liquid with the material and within the interstices thereof.

2. Apparatus as claimed in claim 1, wherein the roller includes a fixed support member extending longitudinally thereof and from which the transducer means is suspended within the confining liquid in the roller.

3. Apparatus as claimed in claim 1, wherein means are provided for circulating the confining liquid in the roller.

4. Apparatus for treating materials in the form of filaments, fibers, yarns and fabrics, strands and other elements formed therefrom; and comprising a tank for holding a treating liquid of predetermined composition selected to impart desired characteristics and quality to the material, an immersion roller providing a rigid surface of substantial extent across the tank and immersed in the treating liquid and containing a confined liquid

7

at least partially immersed in the treating liquid but isolated therefrom, means for directing the material through the treating tank along two substantially parallel runs and under and in close proximity to the said rigid surface, and transducer means positioned in the roller and between the two runs of the material and separately immersed in the isolated body of confined liquid for imparting sonic through ultrasonic vibrations through the said surface to the material to increase impregnation and intimate association of the treating liquid with the material and within the interstices thereof.

5. Apparatus as claimed in claim 4, wherein additional transducer means is provided in line with the aforesaid transducer means between the two runs of the material.

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