Nov. 16, 1954 G. E. HENRY 2,694,307

APPARATUS FOR DYEING TEXTILE MATERIALS
BY IMMERSION AND BEATING

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Fig.1.

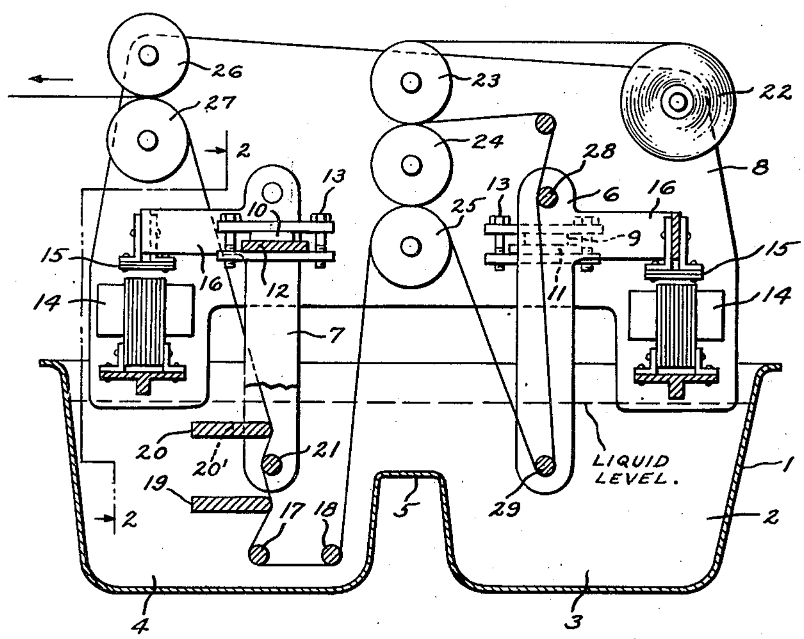
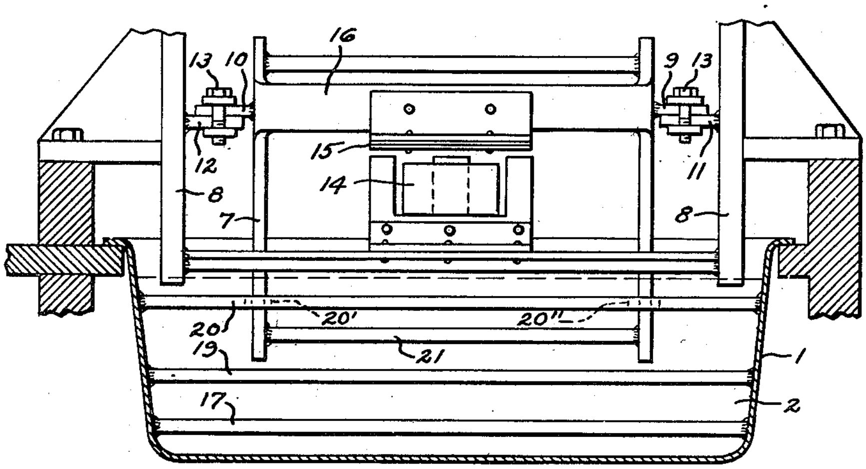


Fig.2.



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APPARATUS FOR DYEING TEXTILE MATERIALS BY IMMERSION AND BEATING

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2 Claims. (Cl. 68—43)

My invention relates to apparatus for dyeing textile materials, and more particularly to dyeing apparatus wherein the material to be dyed is immersed within a fluid dyeing bath.

The most common method of dyeing textile materials is merely to dip the material within a fluid bath containing the dyestuff. Each dip of the material may be followed by a passage of the material between squeezing rollers. However, with many textile materials such as those having layers of closely woven threads, the mere dipping of the material within the bath and subsequent squeezing is not sufficient to produce an even and thorough penetration of the dyestuff into all of the threads or filament bodies of the material. If the dye does not penetrate deep enough, there is a marked difference between the surface color and the internal color, and the material does not retain its original surface color when subjected to washing, light, and rubbing, such as are encountered in normal usage.

One method which has heretofore been suggested to produce a more uniform diffusion and penetration of the dye throughout the material is to subject the dye bath itself to high power vibration at ultrasonic frequency in the neighborhood of one hundred thousand cycles per second. While this method has resulted in a somewhat greater measure of dye penetration, it requires costly and cumbersome ultrasonic vibration generators and considerable electronic control apparatus.

Accordingly, a principal object of my invention is to provide a relatively simple apparatus for dyeing textiles which produces a marked improvement in the uniformity of dye penetration, and which is inexpensive to construct and install.

In fulfillment of this principal object it is a further object of my invention to provide a new apparatus for dyeing textile materials whereby an improvement in the uniformity of color penetration throughout the material over the color penetration which may be produced by normal dipping methods is as great as, or greater than, seventy-five per cent of the total improvement possible.

A still further object is to provide an improved dyeing apparatus which can be directly operated from the normally available twenty five, fifty, or sixty cycle, 110 or 220 voltage source.

A still further object of my invention is to provide an improved dyeing apparatus which can be easily adapted to existing dyeing apparatus.

In general, the method of operation of my new apparatus comprises the vibration of the textile material itself while it is immersed within the dye bath at a low sonic frequency preferably within a range of about 25 cycles per second to about 1000 cycles per second and with a fairly large peak-to-peak vibratory displacement of the material, at least 0.05 inch and usually greater than 0.1 inch. A considerable improvement in dye penetration results even though the vibration is produced by a relatively low power mechanism. Although the reasons for this marked improvement in dye penetration by the use of this method are not definitely proven, it is considered that the fairly large vibratory displacement of the material forces some of the dyestuff completely through the material, so that the inner threads are impregnated thereby. In addition, the tugging action on the material due to its vibration may be stretching the fibers or threads of the material enough to permit contact between the

dyestuff and the normally unexposed surfaces of the inner fibers or threads.

In a modification of this method, the immersed material is brought into contact with a vibrating member so that a beating action of the material results which increases the agitation of the dyestuff and alternately stretches and relaxes the fibers of the material in order to increase the dye penetration.

The apparatus of my invention comprises a simple vibration producing means which is constructed to operate mechanically upon, and produce corresponding vibrations of, the material to be dyed while it is immersed within the dye bath. The mechanical vibrations are preferably of the shock-excited type and may be transmitted to the material through the vibratile member which supports the material within the bath, or they may be transmitted to the material through a separate vibrating member which comes into contact with the immersed material during the passage of this material through the dye bath. In the preferred embodiment described hereinafter, the vibration of the material is produced by an electromagnet acting upon the dipping frame which either supports or comes into contact with the material as it passes through the fluid dye bath.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, together with further objects and advantages thereof can best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 is a cross sectional view of a dyeing apparatus embodying my invention and illustrating my new method, and Fig. 2 is an elevational view of the dyeing apparatus of Fig. 1 taken from line 2—2 of Fig. 1.

Referring to Fig. 1, I have shown my invention as it might be applied to a double dipping dyeing apparatus in which a vessel **1** containing a fluid dye bath **2** is divided into two sections **3** and **4** respectively by a central ridge **5**. In conjunction with section **3**, I have illustrated an apparatus whereby a simple vibration of the textile material within the bath is produced in order to increase the dye penetration by a type of sieve action of the fluid through the material. In conjunction with section **4**, I have illustrated an apparatus whereby a beating of the textile material within the bath is produced to stretch the fibers as well as to produce this sieve action of the fluid. It is to be understood, of course, that an apparatus employing only a single dip of the material may alternatively be used, and that either of the modifications shown in conjunction with sections **3** and **4** of the dye bath may be used alone to produce a market increase in dye penetration. However, the use of a double dipping apparatus, as shown, is preferred; and by depicting a double dip apparatus, the drawings are simplified considerably since both modifications are illustrated in a single figure.

A pair of dipping frames **6** and **7** are secured to a suitable supporting member **8**, best seen in Fig. 2, so that their lower portions extend into the dye bath sections **3** and **4** respectively. The sides of the upper portion of each dipping frame have a pair of oppositely extending flanges **9** and **10** respectively which are clamped to a pair of bosses **11** and **12** of the supporting member **8**. This clamping arrangement restricts virtually all movement of the frame in a vertical direction but permits a slight measure of horizontal movement of the immersed end of the frames **6** and **7** against the mechanical spring force of the clamps. This spring constant of the clamps, and consequently the frequency of mechanical resonance of a horizontal vibration of the frames, can be controlled by merely adjusting the tightness of the clamping bolts **13**, or by adjusting the effective lengths of the spring flanges.

In order to produce controlled vibrations of the immersed end of each dipping frame, a vibration producing means such as a simple electromagnet **14** is securely mounted adjacent each dipping frame **6** and **7** respectively and operates upon a highy permeable magnetic member **15**, such as a piece of soft iron, respectively attached to a horizontal extension **16** of each frame. Each electromagnet **14** operates in a well known manner to attract soft iron piece **15** periodically into contact with electromagnet **14** and consequently to produce intense shock-type vibration of the attached frame during each alternation of an alternating current of sufficient amplitude supplied to the coils of the electromagnet. If an alternating current of 60 cycles per second, for example, should be applied to the electromagnet **14**, the immersed end of the dipping frame would vibrate at substantially 120 cycles per second. The degree of vibratory displacement depends, of course, upon the magnitude of the gap between the electromagnet **14** and the soft iron member **15**, the amplitude of the applied voltage, and the mechanical resonance condition of the dipping frame itself.

In order to guide the material to be dyed adjacent the immersed end portion of the frame **7** so that a beating action of the frame end portion against the material can be achieved, a pair of guide rods **17** and **18** respectively extend across the dye bath section **4** adjacent the bottom thereof. A pair of stationary guide plates **19** and **20** respectively extend across this section of the dye bath above and below a beating rod **21**, best seen in Fig. 2, which extends across the end of the dipping frame **7**. The material to be dyed is supported across the guide members **19** and **20** with the guide members contacting one side of the material and the beating member **21** arranged to contact the other side of the material. The upper plate **20** has a pair of indentations **20′** and **20″**, indicated by dotted lines in Fig. 2, to allow for the side of the dipping frame **7**. Although a single stationary guide plate may be used, the double plate arrangement herein described tends to localize the beating action within the dye bath itself.

The material to be dyed is fed through the apparatus from a supply roll **22** in a path spaced from the walls of the vessel by means of a conventional system of driving and squeezing rollers **23, 24, 25, 26** and **27** and guiding rods **28**, and **29**. Guide rod **29**, located at the immersed end of the dipping frame **6**, also functions as the vibration transmitting support for the portion of the material which is immersed within section **3** of the dye bath.

In the operation of the above described dyeing apparatus, the material is first threaded along its proper guide path and the dyeing fluid is poured into the vessel **1**. The electromagnets **14** are energized to produce vibration of the frames **6** and **7**, and the material is fed through the bath **2** while the vibration of the frames **6** and **7**, and the consequent vibration of the material, is maintained. In the arrangement shown in section **3** of the vessel **1**, the immersed material is merely vibrated within the dye bath **2**; while in the arrangement shown in section **4** of the vessel **1**, the material is beaten against the support of the stationary plates **19** and **20** by the vibrating end **21** of the dipping frame **7** solely to stretch and relax the fibers of the fabric material within the dye bath.

I have found however that at a frequency of vibration of 120 cycles per second the amount of peak-to-peak vibratory displacement of the material must be about 0.1 inch before any noticeable improvement in dye penetration results. With lower frequencies, a larger vibratory displacement is necessary while with higher frequencies a smaller vibratory displacement is adequate. However, the vibration of the material must be at least in the neighborhood of 25 cycles per second and the vibratory displacement at least about 0.05 inch before any improvement is perceptible. As either, or both, the vibration frequency and the vibratory displacement is increased beyond these minimum amounts, the improvement in dye penetration continues until optimum values are reached beyond which further increases in frequency or displacement have little effect. The cost of producing larger displacements at these higher frequencies soon becomes prohibitive since it is virtually impossible to build a dyeing apparatus that will produce vibrations of the material beyond 1000 cycles per second with a fairly large vibratory peak-to-peak displacement. However, the improvement in dye penetration which I have obtained with frequencies in the neighborhood of 120 cycles per second and with vibratory displacements of the material in the neighborhood of 0.150 inch has been very great. Spectrophotometric analysis of the reflectance of unvibrated samples and vibrated samples of material dyed under identical conditions indicate that improvements in dye penetration up to and above 75 per cent of the total improvement theoretically possible may be attained even under these easily obtainable vibratory conditions. In the typical case recorded by the chart below, the material employed was duck cloth, the dye employed was an anthraquinone vat pigment dye such as a Ponsol G. D. blue double paste with a wetting agent, and the vibration was at 120 cycles per second upon each frame with a peak-to-peak displacement of about 0.15 inch. In this instance, vibrated and unvibrated samples dyed under identical conditions were subjected to spectrophotometric analysis of surface and internal threads. A greater area under the spectrophotometric curve indicates a more imperfect dyeing.

Sample Tested	Spectrophotometer Curve Area (in Arbitrary Unit)	Area of Improvement
Internal Threads—unvibrated	352	
Surface Threads—unvibrated	255	
Area Representing Total Improvement Theoretically Possible		97
Internal Threads—After vibration	279	
Area Representing Improvement Achieved by Vibration		73
Percent of Total Possible Improvement=73/97=75%.		

Similar noticeable improvement in uniformity of resulting surface and internal color of dyed material has been obtained using either the sieve vibration or the beating type vibration alone.

It is to be understood that although I have described particular methods and apparatus embodying my invention, many other modifications will obviously occur to those skilled in the art and I, therefore, intend by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for dyeing fabrics comprising a vessel for containing a dye bath, two spaced guide members located within said vessel for supporting a fabric within said dye bath, means to convey said material across said guide members in a path spaced from the walls of said vessel, a beating member supported for vibration in a region extending between said guide members over a range of travel contacting a fabric supported across said guide members, said guide members contacting one side of said material and said beating member being arranged to contact the other side of said material, a magnetically permeable member secured to said beating member, and an electromagnet spaced a small distance from said magnetically permeable member for attracting said permeable member periodically into contact therewith to produce intense shock-type vibration of said beating member solely to stretch and relax the fibers of said fabric within said dye bath.

2. Apparatus for dyeing a textile material comprising a vessel for containing a dye bath, two spaced guide members located within said vessel for supporting a textile material within a dye bath away from the walls of said vessel, a supporting member, a frame pivotally mounted on said supporting member and having two extensions radiating in different directions from its pivotal mounting, one of said extensions having a beating member at its end portion for contacting a material supported across said guide members and the other of said extensions having a magnetically permeable member adjacent the end thereof, and an electromagnet secured to said supporting member and closely spaced from said permeable member for attracting said permeable member periodically into contact therewith to produce shock-type vibratory displacement of said beating member.

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