Feb. 1, 1966 S. KELEN ETAL 3,231,908

CARPET DYEING METHOD AND APPARATUS

Filed Aug. 28, 1962 2 Sheets-Sheet 1

Fig. 1

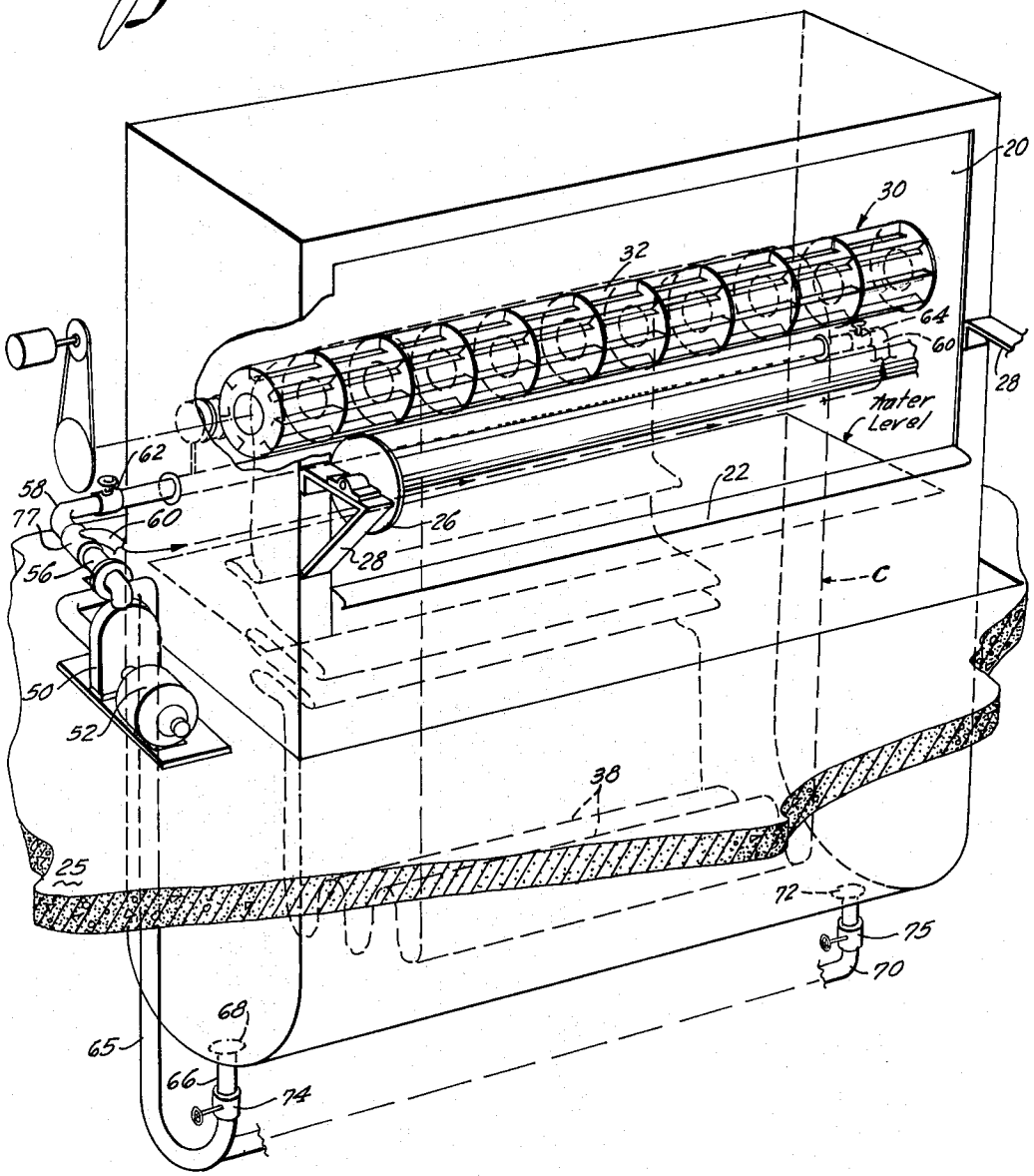


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Fig. 2

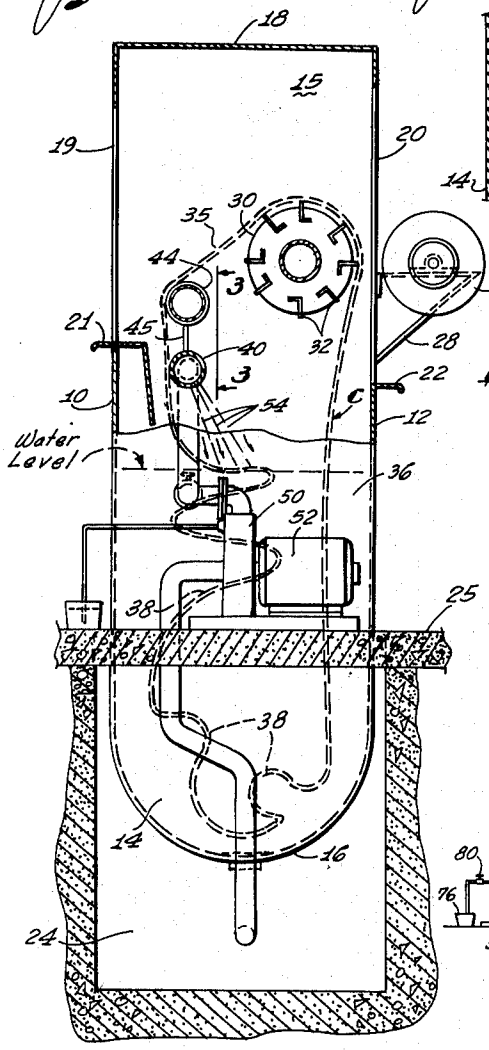



Fig. 3

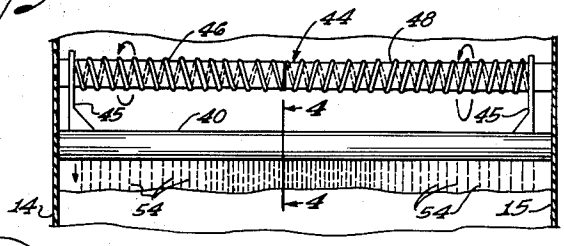



Fig. 4

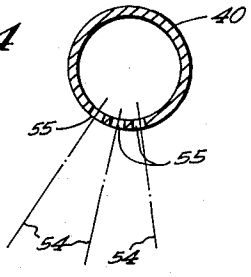



Fig. 5

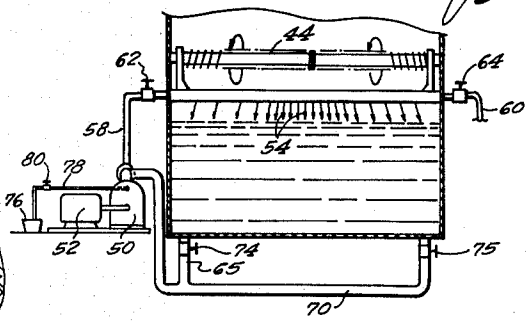



Fig. 6

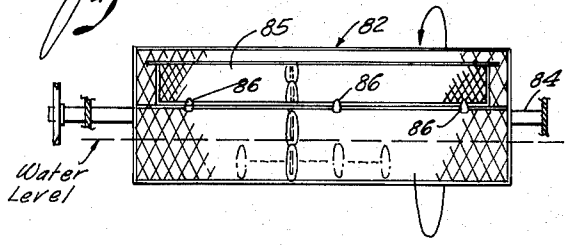
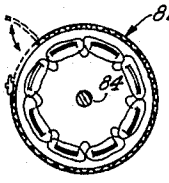



Fig. 7

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3,231,908

# CARPET DYEING METHOD AND APPARATUS

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13 Claims. (Cl. 8—152)

This invention relates to the dyeing of carpets and is particularly directed to an improved method of open dyeing that has special utility for dyeing carpets made of synthetic fibres such as nylon fibres.

The problem is to dye new carpets in long lengths expeditiously and in a manner that results in level coloring of the carpet, i.e., close uniformity of color throughout the area of the carpet. Such uniformity is commonly tested by cutting small samples or swatches from the central region and the opposite marginal regions of an end of the carpet and then carefully comparing the samples.

In open dyeing a long strip of carpet with its ends temporarily sewn together to form a continuous carpet strip is run continuously through a dye solution with the carpet spread to its full width; whereas in rope dyeing the carpet is bunched in width to run through the dye solution in compact rope-like form. Both of these procedures have their advantages and disadvantages.

Rope dyeing is the more prevalent procedure because is saves time and does readily produce uniform coloring. Unfortunately, however, rope dyeing reduces the fluff of nylon carpeting to result in lowered quality. An additional disadvantage is that rope dyeing shrinks a nylon carpet to necessitate an additional stretching operation after the carpet is dyed.

On the other hand, conventional open dyeing of a nylon carpet results in a fluffier carpet than rope dyeing. In fact, open dyeing can be used to produce a nylon carpet that is fluffier than a rope-dyed carpet of the same weight per square yard or can be used to produce a nylon carpet that has the same quality in appearance as a rope-dyed carpet but is actually of less weight per square yard than the rope dyed carpet. Open dyeing, moreover, does not shrink a nylon carpet.

The serious disadvantage of conventional open dyeing of nylon carpets, however, is the excessive time required. The color is seldom uniform after a boiling period that would be adequate for rope dyeing and prolonged running of the carpet through the boiling solution becomes necessary to obtain uniformity. In rope dyeing, uniformity of color may be achieved within a boiling period of only 15 minutes but in conventional open dyeing it is commonly necessary to carry out the boiling operation for a period of one to three hours.

The present invention reduces the time required for open dyeing and thereby makes open dyeing comparable in cost to rope dyeing. Thus the invention combines the advantages of both open dyeing and rope dyeing without incurring the disadvantages of either of the two procedures.

The difficulty in open dyeing is the tendency for the color to be weaker in the longitudinal central region of the carpet than in the two side marginal regions. In addition, too often the colors in the two marginal regions do not match each other. It has been discovered that these uneven color effects are inherent in the conditions which exist in conventional open dyeing as distinguished from rope dyeing.

In the first place, it has been found that since the carpet continuously absorbs dye from the solution, portions of the dye solution immediately adjacent a traveling surface of the carpet tend to become partially exhausted unless there is considerable turbulence for continually bringing fresh solution into contact with the carpet. The dynamics of the rope dyeing procedure are highly conducive to turbulence in the dye solution because the carpet changes configuration radically and rapidly as it travels through the solution and as it is withdrawn from the solution. On the other hand, in open dyeing the configuration in width is constant and the smooth configuration of the fully spread carpet as it is drawn through the dye solution is not conducive to active turbulence.



In the second place, it has been found that when a carpet that is constantly spread to full width travels through a dye solution that is richer in dye ingredients in one part of the tank than in another part, the carpet correspondingly picks up different concentrations of dye over its width. In rope dyeing, however, the carpet is concentrated in a small area of the tank. Such uneven dye concentration may arise from various causes and is always created when dye is added to the water in the tank by the conventional procedure of introducing small quantities of the dye into different parts of the tank.

In the third place, when a carpet is spread to full width in a tank a lesser volume of the dye solution is available per square inch of carpet in the longitudinal central region of the traveling carpet than in the two side marginal regions with the consequence that the central region tends to be lighter in color. This fact may be appreciated when it is considered that the side edges of the carpet are spaced liberally from the corresponding walls of the tank so that substantial volumes of solution are available in wide ranges of radial directions from the two marginal regions of the carpet, whereas in the central area of the carpet the solution is available only in restricted directions perpendicular to the carpet. It is also to be noted that in the submerged folded portions of the carpet, the side margins are more exposed for dye absorption than the longitudinal central region of the carpet.

Based on this discovery of the difficulties inherent in open dyeing, the invention meets the situation by continuously pumping dye solution from the tank and returning the dye solution continuously in the form of jet streams distributed across the tank. The jet streams create violent turbulence to bring fresh dye solution continuously to the traveling carpet and to prevent any significant differences in dye concentration over the area of the tank.

A special advantage of the invention is that it is a simple matter to arrange for a greater volume of the dye solution to be returned by the jet streams in the region of the central area of the traveling carpet than in the regions of the two margins of the carpet. The jet streams in the central area may be enlarged for this purpose but we prefer to make all of the jet streams alike and to crowd more jet streams into the central region and thus equalize the volume of dye solution available in the central region with the volumes available in the two side regions.

The invention also reduces the tendency for the newly introduced dye to cause wide variations in dye concentration in the different regions of the tank. For this purpose provision is made to introduce dye constituents at the intake of the pump for intermixture with the water inside the pump and in the line from the pump to the nozzle openings that produce the jet streams. Thus the newly introduced dye constituents are immediately distributed among the jet streams and the turbulence created by the jet streams quickly spreads the added material uniformly throughout the tank.

The features and advantages of the invention may be understood from the following detailed description and the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

FIG. 1 is a schematic perspective view of the initial embodiment of the invention;

FIG. 2 is a view of the embodiment partly in end elevation and partly in section showing how the continuous strip of carpet is processed;

FIG. 3 is a fragmentary side elevational view showing how the jet streams are more concentrated in spacing in the central region of the tank and also showing how a support tube for a pair of spreading rollers is given the additional function of serving as a manifold to produce the jet streams;

FIG. 4 is an enlarged transverse section taken along the line 4—4 of FIG. 3 to show how the support tube is bored to provide the required nozzle openings;

FIG. 5 is a fragmentary view, partly in side elevation and partly in section, showing how a supply of the dye constituents may be connected to the intake side of the pump;

FIG. 6 is an elevational view showing how a closed rotary basket or cage may be used in the tank for dyeing yarn; and

FIG. 7 is a transverse section of the structure shown in FIG. 6.

In the construction shown in the drawings, the tank has two opposite side walls **10** and **12**, two opposite end walls **14** and **15** and a cylindrically curved bottom wall **16**. The two end walls **14** and **15** are extended upward to support an overhead wall **18** and to form large side openings **19** and **20** on opposite sides of the tank that extend for the full length of the tank for convenient access to the tank interior. The two side openings **19** and **20** are provided with suitable ledges **21** and **22** respectively, along their bottom edges. The tank is suitably supported with its bottom portion in a well **24** below the level of a floor **25**.

A carpet, generally designated C, that is to be dyed may be a relatively short carpet, for example of a length of 90 feet, or may be a long carpet of a length of 400 feet or more. An exterior longitudinal roll **26** journalled on brackets **28** outside the side openings **20** is provided to facilitate introducing the carpet into the tank and to facilitate subsequent withdrawal of the carpet from the tank. When the carpet is fully loaded into the tank the two ends of the carpet are temporarily sewn together to make a continuous carpet strip.

The continuous carpet strip is continuously driven by a power-actuated drive roll **30** of a well known construction which has longitudinal bars **32** spaced around its circumference for contacting the carpet strip with the required driving traction. The drive roll **30** pulls the carpet strip upward and forms a loop **35** of the carpet strip above the level of the dye solution **36** in the tank.

The carpet that travels downward from the drive roll **30** accumulates in the form of a large number of folds **38** in the bottom of the tank, the major portion of the traveling carpet being stored in the form of the submerged folds at all times during the dyeing operation. As the traveling carpet strip emerges from the dye solution, it is guided by a smooth transverse support beam **40** to make contact with a spreading roll **44**, the spreading roll being journalled in brackets **45** that extend upward from the beam **40**. The spreading roll **44** which may be driven in the same direction as the carpet at a slightly faster rate than the travel of the carpet strip has a spiral rib **46** (FIG. 3) on its left half that tends to spread the carpet leftward and has a similar spiral rib **48** on its right half that tends to spread the carpet rightward, the two ribs cooperating to have a lateral stretching effect on the traveling carpet. In a typical construction, the support beam **40** is in the form of a smooth stainless steel tube approximately 5 inches in diameter.

All of the structure described to this point is conventional and old in the art. The invention adds a circulation pump **50** driven by a motor **52** and gives the tubular support beam **40** the added function of serving as a



fluid passage member or manifold tube for distributing the recirculated dye solution in the form of numerous jet streams **54** as indicated in FIGS. 3, 4 and 5. For this purpose the manifold tube **40** is provided with numerous nozzle elements in the form of bores **55** which are more numerous per unit length of the tube in the longitudinal middle region of the tube than in the regions near the two opposite ends of the tube that correspond to the two opposite margins of the traveling carpet.

If the bores **55** are too small and/or too few, the jet streams **54** have too high a velocity with a consequent tendency to damage the carpet. With the circulation pump **50** delivering 50 gallons per minute, the bores **55** may be $\frac{9}{16}$ inch diameter. If the velocity is found to be too high, it is a simple matter to provide additional bores to reduce the velocity.

A pipe **56** connected to the output side of the pump **50** has a first branch **58** connected to one end of the tubular beam **40** and a second branch **60** connected to the second end of the tubular beam, the two branches being provided with corresponding valves **62** and **64**. The two valves **62** and **64** are adjusted as required to equalize the flow to the two ends of the manifold tube **40** and thus equalize the jet stream flow from the two longitudinal halves of the manifold tube.

In like manner a pipe **65** connected to the intake side of the pump **50** has a first branch **66** connected to a bottom outlet **68** at one end of the tank and a second branch **70** connected to a bottom outlet **72** at the other end of the tank. These two branch pipes **66** and **70** may be provided with corresponding valves **74** and **75** for equalizing the rates of return flow through the two pipes. For the purpose of bringing the circulating water to a boil a suitable heat exchanger **77** may be connected to the pipe **56** on the output side of the pump **50** as indicated in FIG. 1.

Any suitable means may be provided to introduce chemicals and dye materials to the circulation system. As indicated in FIG. 5, the dyestuffs to be added may be placed in a container **76** with a suction tube **78** extending from the container to the intake side of the pump **50**. The suction tube **78** is provided with a suitable cut-off valve **80**.

A typical dyeing procedure with the described apparatus is as follows. With a strip of carpet loaded into the tank with the aid of the exterior roll **26** and with the two opposite ends of the carpet sewn together to form a continuous carpet strip and with the tank filled with water to the level indicated in FIG. 2, the heating means is energized to raise the temperature of the water to the boiling point. In accord with the usual practice, the required chemicals are added while the water is relatively cool, say at 60° F., and the dye is added when the water reaches 100° F. In the meantime the drive roll **30** is actuated to cause the carpet strip to travel continuously into and out of the water.

The chemicals and the dye are added in the manner shown in FIG. 5 by placing the ingredients in the container **76** and opening the valve **80** to cause the material to be sucked into the intake of the pump **50**. The material introduced into the intake side of the pump in this manner mingles with the water on the output side of the pump and is distributed through the manifold tube **40** to the various jet streams **54**.

As the strip of carpet is drawn upward out of the dye solution in the form of the carpet loop **35** the stored portion of the carpet is progressively unfolded. The upward travel of the carpet and the unfolding of the submerged carpet tends to cause the submerged folds **38** to be drawn to the surface but this tendency is counteracted by the downward force of the jet streams **54** as may be seen in FIG. 2. It is also to be noted that the downwardly directed jet streams being directed against the submerged carpet for the full width of the carpet

bring the freshly recirculated unspent dye solution into distributed contact with the surface of the carpet.

It is to be noted that the provision of a greater distribution density of the nozzle bores **55** in the central region of the manifold tube **40** not only compensates for the inherent tendency for less coloring to reach the longitudinal central portion of the carpet strip but also compensates for the pressure drop in the central portion of the manifold tube. In other words the increased number of nozzle bores **55** per unit length of the manifold tube **40** in the central region of the manifold tube is intended to compensate for the pressure drop in the manifold tube to equalize the velocity among the jet streams **54** and is intended additionally to supply more of the recirculated solution per inch width of the carpet in the central longitudinal area of the carpet than in the two opposite marginal areas.

When the chemicals and dyes are added on the intake side of the pump **50** the materials are quickly uniformly distributed throughout the volume of the water in the tank and subsequently, during the boiling operation, the recirculation of the solution by means of the numerous jet streams keeps the dye concentration uniform throughout the solution, there being no possibility of accumulation of spent dye solution in any part of the tank. The use of two bottom outlets in the tank to return the dye solution to the pump **50** is helpful for maintaining uniform dye concentration but only one bottom outlet, preferably a central bottom outlet, may be provided if desired.

After the dye solution boils for 15 minutes with the carpet strip traveling continuously through the dye solution, samples are cut out at the sewn ends of the carpet, one swatch being taken from the center of the carpet and two swatches being taken from the opposite margins respectively. These swatches are carefully compared under suitable lighting. If the three swatches are uniform, the carpet may be withdrawn from the tank at this time. If the three swatches are not uniform, the boiling is continued for another 15 minutes with the carpet traveling continuously and swatches are again taken from the carpet for test. In many instances a 15 minute boiling period is enough and more than 30 minutes is required only when certain sensitive dyes are used which require an additional 10 minutes of boiling. Before the carpet is removed, the dye solution is drained from the tank and is replaced by clear water for rinsing the carpet strip. The tank may be drained by connecting a drainage outlet (not shown) to a sewer or the output side of the pump may be connected to the sewer for this purpose.

A further feature of the invention is that it may be employed for dyeing yarn. For this purpose, as shown in FIG. 6, a cylindrical basket or cage **82** of open wire construction is mounted on a power actuated horizontal shaft **84** for rotation with the lower side of the revolving cage submerged in the dye solution as indicated. The cage **82** is provided with a longitudinal closure **85** mounted on suitable hinges **86**. The same operating cycle is used and with the jet streams directed downward against the revolving cage, color uniformity is quickly achieved.

Our description in specific detail of the preferred practices of the invention will suggest various changes, substitutions and other departures from our disclosure within the spirit and scope of the appended claims.

We claim:

**1.** A method of dyeing a long length of carpet characterized by the steps of:

placing a body of dye solution in a tank;

joining the ends of the carpet together to make a continuous strip of carpet and continuously running the carpet strip through the water by continuously withdrawing and returning a loop of the carpet strip with the major portion of the carpet strip submerged in the tank at all times; and

continuously circulating the dye solution by continuously pumping a portion of the dye solution out of the tank and returning the dye solution in the form of numerous jet streams above the liquid level of the body of solution directed downward against the portion of the submerged carpet in the tank to keep the portion submerged.

**2.** In an apparatus for dyeing a long continuous strip of carpet, the combination of:

a tank to confine a body of dye solution;

means to continuously withdraw a portion of the carpet from the solution with the carpet spread in width to form a traveling loop above the solution to run the carpet strip continuously through the dye solution with the major portion of the running carpet stored in folded configuration in the solution below the loop at all times;

a pump having its intake side connected to the tank to continuously withdraw dye solution from the tank; and

a series of nozzle elements directed downward above the body of the solution inside the loop and connected to the output side of the pump to return the dye solution to the tank in the form of jet streams distributed across the width of the carpet in the tank with the jet streams directed downward to the region of the submerged portion of the running carpet to continuously counteract the tendency of the submerged portion of the carpet to rise to the top of the body of solution and to agitate the body of solution to promote uniformity of the dye solution.

**3.** An apparatus as set forth in claim **2** in which said nozzle elements are spaced and dimensioned for a greater volume of return flow of the dye solution per foot of width of the carpet in the central longitudinal region of the running carpet than in the two opposite marginal regions of the running carpet.

**4.** In an apparatus for dyeing a long continuous strip of carpet, the combination of:

a tank to confine a body of dye solution;

a fluid passage member extending across the tank above the confined body of dye solution, said fluid passage member having downwardly directed nozzle outlets distributed along its length;

means to continuously withdraw a portion of the carpet strip from the body of solution to a region above the body of the solution and to continuously return the portion of the carpet strip to the body of solution to form a continuously traveling loop of the carpet strip enclosing said fluid passage member with the major portion of the running carpet in the body of dye solution; and

a pump having its intake side connected to the tank to withdraw dye solution from the tank and having its output side connected to said pump to return the dye solution to the tank in the form of numerous jet streams distributed across the tank and across the width of the traveling carpet strip.

**5.** An apparatus as set forth in claim **4** in which the output side of said pump is connected to opposite ends of said fluid passage member.

**6.** A combination as set forth in claim **4** which includes adjustable means for controlling the division of the flow from the tank to the two opposite ends respectively of the fluid passage member for regulation to equalize the flow to the two ends of the fluid passage member.

**7.** An apparatus as set forth in claim **4**

in which the flow capacity of the nozzle elements per longitudinal foot of the fluid passage member in the central longitudinal region of the fluid passage member is greater than in the end portions of the fluid passage member.

**8.** In an apparatus for dyeing a long continuous strip of carpet, the combination of:

a tank to confine a body of dye solution;

means to continuously withdraw from the body of solution and return to the body of solution a portion of the carpet to form a running loop of carpet outside the body of dye solution;

rotary means extending across the tank to engage the carpet loop from inside the loop to spread the loop to the full width of the carpet;

a fixed hollow member extending across the tank to support said rotary means inside the loop, said hollow member having numerous outlets distributed along its length; and

a pump having its intake side connected to the tank and its output side connected to said hollow member to continuously withdraw dye solution from the tank and return the dye solution to said outlets to form jet streams.

9. In a process of dyeing a long strip of carpet in a body of dye solution in a tank wherein the ends of the strip are connected together to form a continuous strip spread in width and a portion of the spread strip is formed into a running loop above the body of solution with the major portion of the continuous strip in the body of solution, an improvement to counteract the tendency of the carpet to color unevenly, said improvement comprising:

continuously withdrawing dye solution from the tank and returning the dye solution to the tank with the return flow distributed across the width of the carpet and with the rate of return flow per unit measurement of width of the carpet increasing from the two regions of the opposite longitudinal edges of the carpet towards the central longitudinal region of the carpet to compensate for greater accessibility of the solution to the carpet to the regions of the longitudinal edges of the carpet than to the central longitudinal region of the carpet.

10. An improvement as set forth in claim 9 in which the return flow is formed into jets inside the running loop above the level of the body of solution directed downward to the region of the submerged portion of the carpet to counteract the tendency of the submerged portion to float on the body of the solution and to agitate the body of the solution to promote uniformity in the concentration of the solution.

11. In a process of dyeing a long strip of carpet in a body of dye solution in a tank wherein the ends of the strip are connected together to form a continuous strip spread in width and a portion of the spread strip is formed into a running loop above the body of solution with the major portion of the strip submerged in the body of solution, the improvement comprising:

continuously withdrawing dye solution from the tank and returning the dye solution to the tank above the body of solution in the tank inside the loop in the form of a series of jets distributed across the width of the carpet in the region where the running loop draws the strip from the body of solution with the jets directed downward towards the surface of the solution to counteract the tendency of the submerged carpet to float on the body of solution and to counteract the tendency of the running loop to pull the submerged carpet upward out of the body of solution.

12. In an apparatus for dyeing a long continuous strip of carpet by means of a body of a dye solution in a tank wherein a running loop of the continuous strip is formed above the body of solution by a transverse support beam in combination with a spreading roll and a drive roll, the improvement comprising:

said transverse support beam being hollow with numerous downwardly directed discharge openings distributed along its length; and

the provision of means to continuously withdraw dye solution from the tank and to force the dye solution into the interior of the support beam for continuous recirculation of the dye solution and for continuously agitating the dye solution and for applying downwardly directed force to the submerged portion of the carpet to counteract the tendency of the submerged portion to float on the body of solution.

13. An improvement as set forth in claim 13 in which the flow capacity of the distributed discharge openings per unit measurement of the width of the carpet increases from the opposite ends of the support beam to the central longitudinal portion of the support beam to compensate for greater accessibility of the solution to the regions of the longitudinal edges of the carpet than to the central longitudinal region of the carpet.

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