Dec. 3, 1968 A. R. WINCH 3,413,825

METERING WARP KNIT FABRICS

Original Filed Sept. 24, 1964 2 Sheets-Sheet 1

Fig. 1.

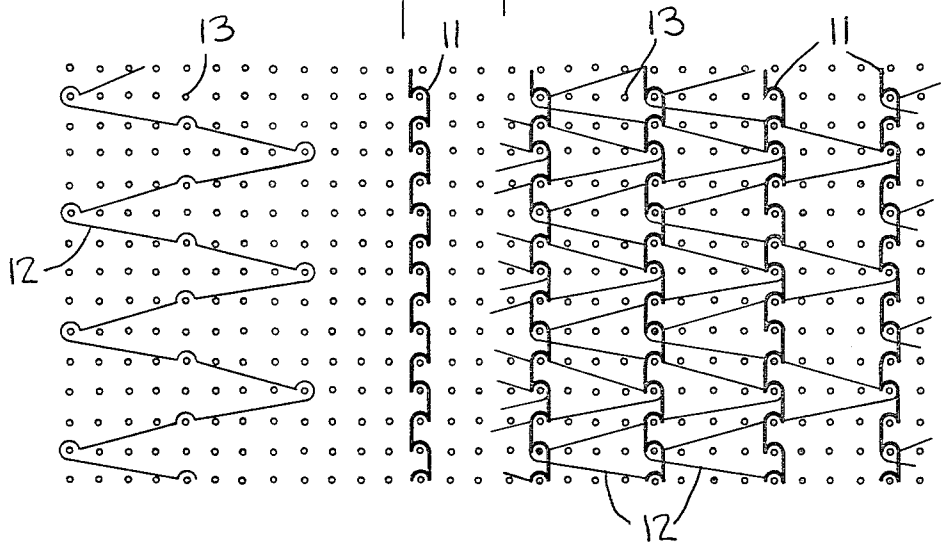
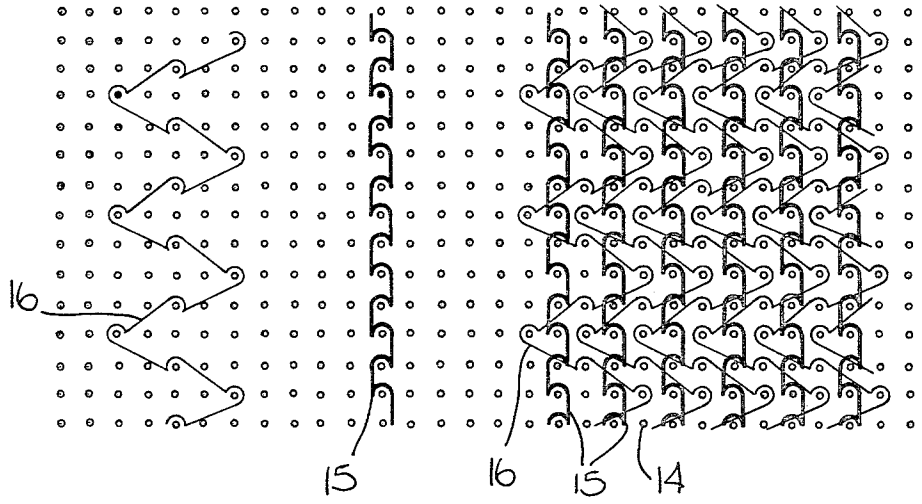


Fig. 2.



METERING WARP KNIT FABRICS

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Fig 3.

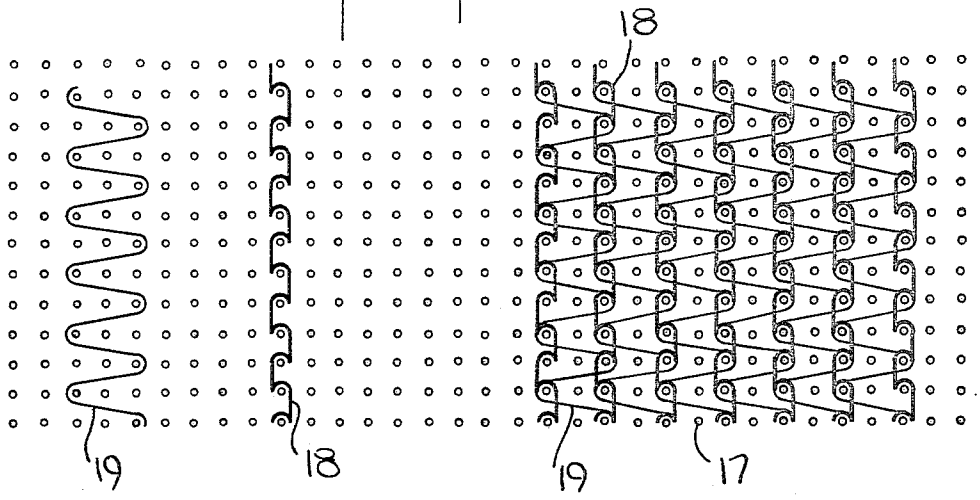
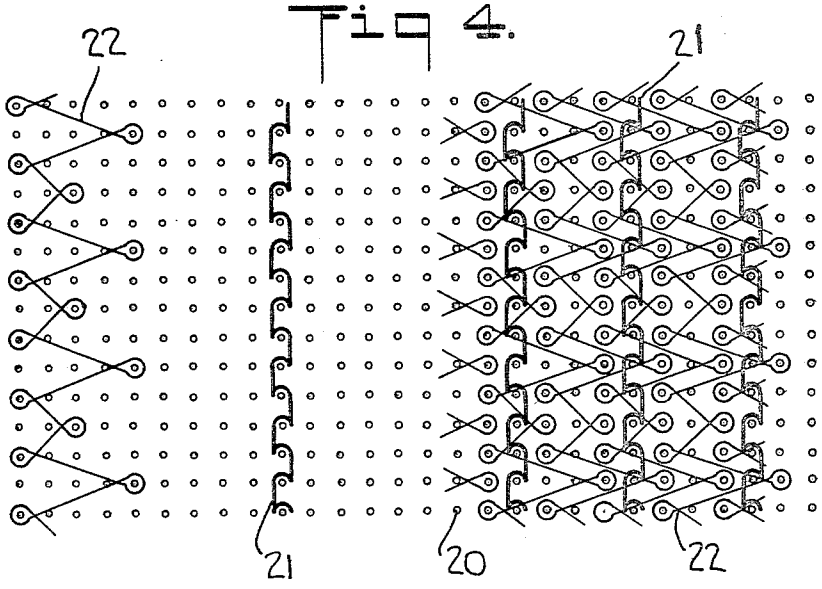


Fig 4.



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METERING WARP KNIT FABRICS

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Continuation of application Ser. No. 399,042, Sept. 24, 1964, which is a continuation-in-part of application Ser. No. 339,055, Dec. 30, 1963. This application June 30, 1967, Ser. No. 650,551

5 Claims. (Cl. 66—192)

ABSTRACT OF THE DISCLOSURE

A warped knit continuous filament fabric carrying a depositant and having a low stretch in the warpwise direction and a high stretch in the walewise direction, said fabric including two sets of yarn having a denier of from about 15 to about 150, containing from about 5 to about 75 filaments per yarn and having a denier per fil of from about 0.5 to about 20, one set of yarns comprising yarns in the form of a number of parallel chains extending in the warpwise direction and the other set comprising yarns extending in the walewise direction.

This invention relates to light weight, open construction, warp knit carrier and metering fabrics. This application is a continuation of application Ser. No. 399,042, filed Sept. 24, 1964 and now abandoned, which is a continuation-in-part of application Ser. No. 339,055, filed Dec. 30, 1963.

It has been found useful to provide fabrics in which or on which is contained a migratable material. Such fabrics are placed upon surfaces onto which it is desired to deposit the material. Since the fabric is used to carry temporarily a foreign material and subsequently to deposit or meter the material onto a surface it may be referred to as a "carrier" or "metering" fabric. Since the foreign material is only temporarily carried by the fabric and is subsequently caused at least partially to migrate therefrom and be deposited onto a surface it may be referred to as a "depositant." The surface may be referred to as a "receiver surface" since it ultimately receives the depositant.

One known embodiment of this technique has been to provide a woven or non-woven fabric contained in or on which are one or more of fertilizers, herbicides, insecticides, plant hormones, nematocides or other horticultural chemical or chemicals.

The fabric is laid upon a cultivated area and natural moisture, such as rain and dew, or artificial moisture, such as sprinkled water, dissolves the fertilizer from the fabric and washes it onto the soil into which it is absorbed. The term "non-woven" means that the fabric consists of a more or less random array of filaments or fibers; i.e., there is no uniform pattern of interweaving, interlooping or interlacing of the filaments or fibers.

Since the purpose of the fabric merely is to serve as a carrier, it is highly desirable that the fabric contain as little filament or fiber as would be possible to provide adequate strength and dimensional stability; any amount of filament or fiber beyond that which would be necessary to provide a base for carrying an adequate amount of depositant, which additional amount is necessitated by an otherwise lack of enough strength or dimensional stability in the fabric, adds cost to the fabric without contributing to its ultimate purpose, viz., the carrying of depositant for subsequent distribution. It is important that carrier fabrics be of significant strength and dimensional stability. This is necessary because it is usually most expedient timewise that the fabric be laid on the receiver surface in the form of large unitary pieces (e.g., 1 foot or more

wide and 10 feet or more long). Such large pieces in order to be self-supporting and conveniently handled as they are laid must be reasonably strong and dimensionally stable. The large size of the fabric pieces increases the strains imposed on the filaments or fibers as the fabric is laid and multiplies the effect of dimensional instability in terms of absolute dimensions. Even when smaller fabric pieces are used, strength is important because of such factors as potential snagging of the fabric or irregularities on the receiver surface (such as stones and stubble on a field).

It is found that in order to make non-woven carrier fabrics of adequate strength, it is necessary to use a substantially greater amount of filament or fiber than would be necessary simply to provide a base for an adequate concentration (amount per unit area) of depositant. This is because non-woven fabrics depend for their strength upon points of inter-filament or-fiber bonding, entangling or friction; in order to provide adequate strength for carrier fabric use, more of these points must be provided than would occur in a fabric designed merely with adequacy of base for depositant in mind and for any given type of non-woven fabric construction the strength is roughly proportional to the number of said points and the number of points is roughly proportional to the quantity per unit area of filament or fiber.

In the case of woven carrier fabrics, it is found that dimensional stability is a substantial problem. It is found that in order to make woven carrier fabrics of adequate dimensional stability, it is necessary to use a substantially greater amount of filament or yarn than would be necessary simply to provide a base for an adequate concentration (amount per unit area) of depositant. This is because woven fabrics depend for their dimensional stability upon friction between the inter-woven filaments or yarns. When the woven carrier fabric is of the high degree of openess which minimizes cost with respect to the amount of filament or yarn per unit area of fabric, there is relatively little inter-filament or-yarn friction, the warp and filling filaments or yarns tend to slide over one another at their intersections, which sliding manifests itself as dimensional unstability of the fabric.

Non-woven and woven carrier fabrics have further disadvantages. Non-woven carrier fabric constructions are, practically speaking, not stretchable at all. Woven carrier fabric constructions of the open constructions generally found economically desirable are deformable in the sense that they are lacking in dimensional stability of the yarn lay or weave pattern but they are not stretchable; carrier fabric constructions which are less open are not as dimensionally unstable as the more open constructions and like the more open constructions are not easily stretchable. The term "stretchable" as used in the specification and claims means that the construction of the fabric (as distinguished from the nature of the yarns, filaments or fibers of which the fabric is constructed) imparts to the fabric in a given direction an extensibility of at least about 20% based on the dimension of the fabric in said direction when the fabric is not being extended, this extension occurring in the fabric but not in the yarn and not substantially affecting the knit pattern or yarn lay. The lack of stretchability in non-woven carrier fabrics and in woven carrier fabrics decreases their utility because if they snag (for example on stones or plant growth on the ground) as they are being laid, the non-woven carrier fabrics will not stretch significantly under the strain but will resist and tend to tear and the woven carrier fabrics, if accommodating to the strain, will do so only at the sacrifice of their original dimensions and, thus, will no longer cover the area intended.

Furthermore, non-woven carrier fabrics do not conform in shape readily to irregularities in the receiver sur-

face. This will often be a disadvantage, because, for example, for most efficient and uniform transfer of the agricultural chemicals from the carrier fabric to the ground (receiver), the carrier fabric should lie in good conformance with the ground contours.

Accordingly, it is an object of the present invention to provide carrier fabrics which will be substantially improved with respect to all the aforesaid disadvantages of prior art carrier fabrics. Other objects will be apparent from the description of the present invention herein contained.

In accordance with one aspect of the invention there is provided a warp-knit carrier fabric of open construction having a yield of from about 10 to about 500 square yards per pound. The yield preferably is from about 20 to about 400 square yards per pound and most desirably from about 30 to about 300 square yards per pound.

For such end use, the fabric is preferably knit of continuous filament yarns since in that manner the necessary strength can be achieved at low deniers. Advantageously, the fabric is knit on a double bar machine, the yarns of one bar forming longitudinally extending chains to lock the essentially transversely extending yarns of the other bar into predetermined position in forming the fabric. Because of the loop-formation of the yarns in forming the chains, these chains exhibit increased strength. The yarns from which the chains are formed may be of any denier from about 10 to about 1000, but preferably have a denier of from about 15 to about 600 and most desirably from about 20 to about 300. The transversely extending yarns may be of any denier from about 10 to about 1000, but preferably have a denier of from about 10 to about 600 and most desirably from about 20 to about 300.

Continuous filaments or continuous filament yarns are preferred because they have a greater strength to weight ratio than spun yarns.

The number of wales per inch in the fabric may be from about 1 to about 48, preferably from about 2 to about 36 and most desirably from about 3 to about 18. The number of courses per inch in the fabric may be from about 1 to about 50, preferably from about 2 to about 36 and most desirably from about 3 to about 18.

The individual filaments of the chain yarns may have a denier of from about 0.5 to about 20 and the individual filaments of the transversely extending yarns may have a denier of from about 0.5 to about 20. The chain yarns may contain from about 1 to about 150 fils (filaments) per yarn and the transversely extending yarns may contain from about 1 to about 150 fils (filaments) per yarn. Preferably, the chain yarns have a denier of from about 15 to about 150 and contain from about 5 to about 75 fils per yarn. Most desirably, the chain yarns have a denier of from about 20 to about 75 and contain from about 10 to about 75 fils per yarn. Preferably, the traversely extending yarns have a denier of from about 15 to about 150 and contain from about 5 to about 75 fils per yarn. Most desirably, the transversely extending yarns have a denier of from about 20 to about 75 and contain from about 10 to about 75 fils per yarn.

In speaking of strength of the carrier fabrics of the present invention, it is useful to refer to the direction in which the chain yarns run as the "warpwise direction" and the direction in which the transversely extending yarns extend as the "walewise direction"; these terms derive from the fact that the fabric as it is made by the knitting machine moves in the direction of the chain yarns. Since the fabric is most conveniently packaged, for example as rolls, in the warpwise direction, it is also most conveniently unpackaged and laid out on the receiver surface in the machine direction. Thus, warpwise direction tensile strength is a more important property of the fabric than walewise direction tensile strength. It is convenient to express the strength of the fabric in each direction in terms of strength per unit length or width

in the direction perpendicular thereto. Thus, a desirable balance of weight or cost versus strength is found at warpwise direction tensile strengths of from about 100 to about 30,000 g./inch; the preferred range is from about 200 to about 15,000 g./inch and the most preferred range from about 300 to about 5,000 g./inch. Walewise direction tensile strengths of at least about 100 g./inch are adequate.

A satisfactory construction has been found to involve yarns on one bar of a double bar warp-knitter which yarns span just one needle and form chains, e.g., the bar may be threaded 1 in 2 out and the stitch pattern will be 1–0, 0–1. The yarns of the other bar are the transversely extending yarns; these may only be hooked about adjacent chains and thusly oscillate or zig-zag back and forth between adjacent chains or these may pass over, under, or through or loop about one or more adjacent chains and continue to yet the next further chain and hook about said latter chain and return to the chain which is the starting point of the presently traced path, passing over, under or through or looping about the intermediate chains, and thus proceed in oscillating or zig-zag fashion; each or any loop or hook of each or any transverse yarn may extend about the chain which is contiguous to the point at which the transverse yarn loops or hooks. Alternatively, each or any of the transversely extending yarns may differ from the configurations just described in the following respects: (1) by being hooked only about chain yarn and/or (2) by extending in looped configuration through loops of other transversely extending yarns, which loops may terminate by being hooked about chain yarn at each side of the oscillating or zig-zag path. Furthermore, a transverse yarn need not simply be hooked about single loops of the chains but may enter a chain loop, run along the chain and continue its oscillating or zig-zag path by passing in the opposite direction through a different loop of the same chain.

Where multifilament yarns are employed, the filaments are generally twisted together to permit processing on the knitting machine. Advantageously, there are 10 or fewer turns per inch since low twist yarns, while less expensive, give more cover and thus more uniform distribution of depositant on the receiver surface than high twist yarns.

It is noteworthy that even very low twist yarns, such as yarns having ½ turn of twist or less per inch, can be readily knitted though unsized, whereas for weaving such yarns would require sizing; this is a further advantage over the prior art.

In connection with variations in the width of the carrier fabric, the use of warp-knit fabrics presents certain additional advantages. Thus, the knitting machine may be made to produce in full width and by appropriate omission of certain warp yarns several fabrics of less than full machine width may be simultaneously produced. As compared with having to produce narrower widths by cutting a wide fabric, the invention avoids uneven edges with fiber strands and shreds. Alternatively, the fabric may be produced in full width and by absence of locking between adjacent warps it may neatly be subdivided into several fabrics of lesser width.

The warp knit carrier fabrics of the present invention are essentially non-stretchable in the longitudinal direction (i.e., warpwise direction) but are stretchable in the transverse direction (i.e., walewise direction). This expedites control during the warpwise direction laying of the fabric and, at the same time, if there is snagging upon the receiver surface, prevents tearing without significant over-all fabric distortion by allowing stretch in the walewise direction. Furthermore, the looping of the longitudinal and transverse yarns about each other essentially prevents slipping of the yarns over one another and thus provides dimensional stability even when the knit construction is very light and open.

In the drawings, FIGURES 1–4 are each a diagram-

matic illustration of the construction of a different warp knit carrier fabric according to the present invention.

The drawings will now be described in detail; in the description, the numerical designations for the stitch patterns. In FIGS. 1–3 are those conventionally used for fabrics made on Raschel warp knitting machines and the numerical designations for the stitch pattern in FIG. 4 is that conventionally used for fabrics made on tricot warp knitting machines.

In FIG. 1 to the left there is shown the stitch pattern of the transversely extending yarns **12** which is produced by the back bar of the knitting machine and the stitch pattern of the longitudinally extending yarns **11** which is produced by the front bar, and to the right there is shown the fabric stitch pattern which, of course, is a composite of the longitudinal and transverse yarn stitch patterns. The dots **13** represent the needle positions and from the figure it can be seen that the bar carrying yarns **11** is threaded 1 in 1 out with a 2–0, 0–2 stitch pattern while the bar carrying yarns **12** is threaded 1 in 3 out with a 0–2, 8–10, 18–16, 10–8 stitch pattern. It should be noted that a 2–0, 0–2 stitch pattern on a Raschel warp knitting machine will be equivalent to a 1–0, 0–1 stitch pattern, such as is referred to above, on a tricot warp knitting machine having half the gage number as said first machine.

In the fabric illustrated in FIG. 2, the positions of the needles **14** show that the bar carrying yarn **15** is threaded 1 in 1 out with a 0–2, 2–0 stitch pattern while the bar carrying yarn **16** is threaded 1 in 1 out with a 0–2, 4–6, 10–8, 6–4 stitch pattern.

In the fabric illustrated in FIG. 3, the positions of the needles **17** show that the bar carrying yarn **18** is threaded 1 in 1 out with a 0–2, 2–0 stitch pattern while the bar carrying yarn **19** is threaded 1 in 1 out with a 0–0, 6–6 stitch pattern.

In the fabric illustrated in FIG. 4, the positions of the needles **20** show that the bar carrying yarn **21** is threaded 1 in 1 out with a 1–0, 0–1 stitch pattern while the bar carrying yarn **22** is threaded 1 in 3 out with 1–0, 2–3, 1–0, 4–5 stitch pattern.

The yarns or filaments of which the carrier fabrics of the present invention are comprised may, with respect to chemical identity be any of the conventional textile yarns or filaments.

The yarns or filaments may be formed of regenerated cellulose (e.g., rayon) or of organic derivatives of cellulose such as esters or ethers thereof, for example cellulose organic acid esters such as cellulose acetate, cellulose propionate, cellulose butyrate, cellulose benzoate, cellulose acetate formate, cellulose acetate propionate, cellulose acetate butyrate, and the like, ethers such as ethyl cellulose, etc. The esters may be ripened and acetone-soluble, such as conventional cellulose acetate, or may be substantially fully esterified, i.e., contain fewer than 0.29 free hydroxyl groups per anhydroglucose unit, e.g. cellulose triacetate.

Also, the yarns or filaments may be formed of other thermoplastic or solvent-soluble or dispersible polymeric materials such as superpolyamides, e.g. nylons, superpolyesters such as polyethylene terephthalate, polyglycolic acid and copolymers thereof, acrylonitrile polymers and copolymers, polymers and copolymers of olefins such as ethylene and propylene, of vinyl chloride, of vinyl acetate, of vinylidene chloride, of vinylidene cyanide, and the like.

Furthermore, the yarns or filaments may comprise natural filaments such as silk or yarns made of natural fibers such as wool, cotton, hemp, sisal, ramie, jute, and the like.

The depositant may be applied to the warp knit carrier fabric by conventional coating and impregnating methods. Thus, the depositant may be applied as a liquid, solid, gas, vapor, solution, dispersion or melt. The depositant may be applied as a liquid or from a liquid-medium for example by means of an applicator roll or by spraying or by immersion of the fabric in the liquid or by pouring of the liquid over the fabric. The depositant may be applied as a solid for example in powder form by means of being blown upon the fabric, the surface of which may be rendered adhesive to the powder by means of an adhesive, binder resin, plasticizer or solvent application. The depositant may be applied as a vapor or gas for example by exposing the fabric to the vapor or gas for sufficient time to allow absorption or adsorption.

Binder resins or adhesives or clay may be used in general wherever it is desired to improve adhesion of the depositant to the fabric surface. For example, the depositant may be applied from a clay dispersion whereby clay is simultaneously applied to the fabric. The adhesive or binder resin as applied may be in the form of an uncured resin, a melt, solution, dispersion, emulsion, paste, or tackifiable solid powder, flake or mass of a polymer or other material, e.g., uncured epoxy resin, starch paste, aqueous dispersions of polyvinyl acetate, polyvinyl alcohol, acrylic polymer, and the like.

Solvents or plasticizers for the fabric may be used to render the filaments or yarns of the fabric penetrable by the depositant. Thus, for example, the depositant may be carried in such a solvent or plasticizer medium.

Warp knit carrier fabrics made of conventional cellulose acetate yarns or filaments are particularly useful in the present invention. Cellulose acetate possesses an affinity for hydrophobic materials, such as the depositants often will be, and yet is swelled in aqueous media; this characteristic of cellulose acetate is demonstrated by its ready dyeability with disperse dyestuffs. Thus, the penetration by aqueous media typical of the dyeing of cellulose acetate may be used to impregnate cellulose acetate carrier fabrics with depositants according to the present invention. Furthermore, expedients may be adopted which are unacceptable to the dyeing industry; thus, for example, partial surface penetration (termed "ring" dyeing in the dyeing art), which is objectionable in the dyeing art, will sometimes be preferred in order that the depositant may be washed from the fabric at the desired rate.

The present invention will now be illustrated by means of an example describing the manufacture of a horticultural chemical carrier fabric and the use thereof.

EXAMPLE

Upon a 48 gauge Raschel knitting machine having front and back beams of 42 inches each, 252 ends of 55 denier/15 fil cellulose acetate yarn having a twist of ¼ turn per inch are knitted in the stitch pattern illustrated in FIG. 3. The fabric thus produced has 6 wales per inch and 7 courses per inch and a yield of 74 square yards per pound. Five pieces of this fabric, each 20 inches wide and 10 feet long, are taken to a cultivated field in which there is planted rye grass seed and mustard plant seed to serve as bioassay plants to evaluate the effectiveness of the application of herbicides from the fabric. At the field, one of each of four different herbicidal compositions is applied to one of each of four of the pieces of fabric, simply by passing the fabric over the mouth of a funnel while pouring the composition onto the fabric and allowing excess composition freely to drain through the exit end of the funnel; the herbicidal compositions are prepared as follows:

(1) Ethyl N-N (dipropyl-thiol) carbamate is first dissolved in kerosene and the resultant kerosene solution is emulsified in water;

(2) 2,4-dichloro (phenoxy ethyl sulfate) is dissolved in water;

(3) α,α,α - Trifluoro-2,6-dinitro - N,N dipropyl-paratoluidene is dissolved in water;

(4) Dichlorbenil is suspended in water.

The fifth piece of fabric does not have anything applied to it and thus serves as a control. The five pieces of fabric

are laid upon the field next to each other and anchored by soil pushed onto their edges. After several weeks, it is observed that effective application of herbicide from each of the four treated fabric samples has occurred.

Emphasis has been placed upon the horticultural chemical aspect of the present invention. It should be understood, however, that the utility of the present invention is not thus limited. Thus the warp knit carrier fabrics may carry adhesives and be used to bond the layers of laminates or may carry corrosion inhibitors and be used to wrap and thus protect steel products in storage and the like wherever it is desired to deposit or meter a material ("depositant") in a controlled, uniform manner.

Accordingly, also within the scope of the present invention is the use of the warp knit fabrics to carry solvents to be applied to objects to be cleaned such as used paint brushes. Solvent carrying carrier fabrics according to the present invention may be provided by immersing a small roll of a warp knit fabric into a container of the solvent (such as turpentine for cleaning paint brushes) with the end of the roll within ones grasp at or near the mouth of the container. When the solvent is to be used, the roll end is withdrawn from the container and used to wipe the soiled object (e.g., paint brush); as the solvent is thus used, more fabric is pulled up from the container; when the roll end becomes excessively soiled, the soiled fabric is cut or torn off and disposed of and fresh fabric is withdrawn from the container. It is found that the warp knit fabric will serve for the highly economical application of solvent in remarkably small increments. Because the solvent is applied by use of the warp knit carrier fabrics in very small increments, washing efficiency (quantity of contaminant (e.g., paint) removed per unit quantity of solvent used) is found to be very high.

Furthermore, within the scope of the present invention is the use of the warp knit fabrics to carry adhesive to be used especially in laminating and packaging applications, though also wherever it is desired to apply adhesive in uniform, controlled quantities. Adhesive may be applied to the warp knit fabric by means of conventional coating techniques; thus, for example, the adhesive may be applied to the fabric by means of spraying, contact rolls or dip coating. Any type adhesive may be used; for example, heat-, dielectric-, water- or other solvent-sensitive adhesives. When a water- or other solvent-sensitive adhesive is used, very little of the solvent per unit area of the fabric is needed because of the low weight per unit area of adhesive on the fabric as a result of its very open construction; this is highly advantageous because it will often render a separate drying operation unnecessary, the normal evaporation of the solvent being sufficiently rapid. Thus, for example, when a water-sensitive adhesive, such as dextrin, polyvinyl alcohol, sodium silicate, etc., is used, a very small amount of water may be applied to tackify the adhesive. However, of course, water- or other solvent-sensitive adhesives, such as dextrin, are conveniently initially applied to the fabric from an aqueous or other solvent medium followed by drying; for example, a useful adhesive metering fabric is made by spraying a 50%, by weight, aqueous emulsion of dextrin onto a sample of the fabric illustrated in FIG. 3 and then drying the adhesive-coated fabric in a conventional drying oven at 200° F.

The adventages of the warp knit fabrics of the present invention as compared with woven and non-woven fabrics as enumerated with respect to agricultural chemical metering fabrics clearly generally hold for other uses, too, such as solvent application and adhesive application above described.

It is to be understood that the foregoing detailed description is merely given by way of illustration and that many variations may be made therein without departing from the spirit of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A warp knit carrier fabric haviing a depositant thereon, said fabric including two sets of yarns, comprising,

(A) a first set of yarns knitted into a plurality of spaced wales of chain stitches extending in a warpwise direction,

(B) said chain stitches being spaced from each other a distance of at least three wales,

(C) said first set of yarns having a stitch pattern of 2–0, 0–2,

(D) a second set of yarns which extend in said wale-wise direction interconnecting said spaced chain stitches,

(E) said interconnecting yarns being spaced from each other in a course-wise direction a distance of at least one wale,

(F) said second set of yarns having a stitch pattern of 0–2, 4–6, 10–8, 6–4.

2. The carrier fabric of claim **1**, wherein the depositant thereon is a solvent.

3. The carrier fabric of claim **1**, wherein the depositant is an adhesive.

4. The carrier fabric of claim **1**, wherein the depositant is a horticultural chemical.

5. A warp knit carrier fabric having a depositant thereon, said fabric including two sets of yarns comprising,

(A) a first set of yarns knitted into a plurality of spaced wales of chain stitches extending in a warpwise direction,

(B) said chain stitches being spaced from each other a distance of at least three wales,

(C) said first set of yarns having a stitch construction of 2–0, 0–2,

(D) a second set of yarns which extend in said wale-wise direction interconnecting said spaced chain stitches,

(E) said interconecting yarns being spaced from each other in a course-wise direction a distance of at least one wale,

(F) said second set of yarns having a stitch pattern of 0–2, 8–10, 18–16, 10–8.

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