

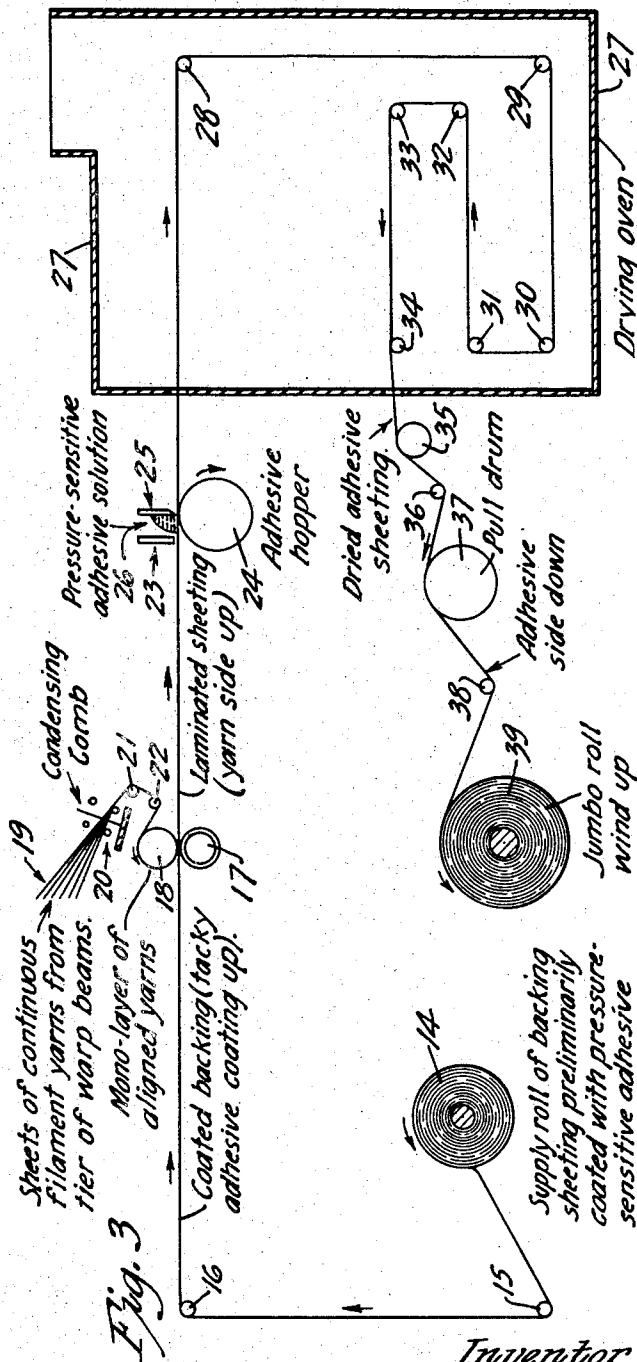
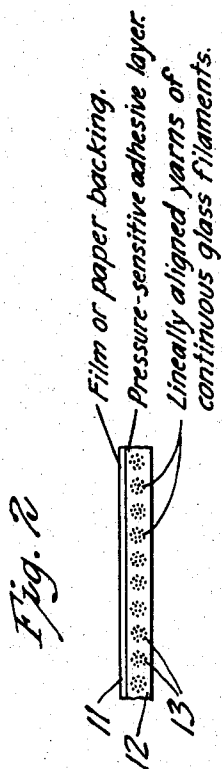
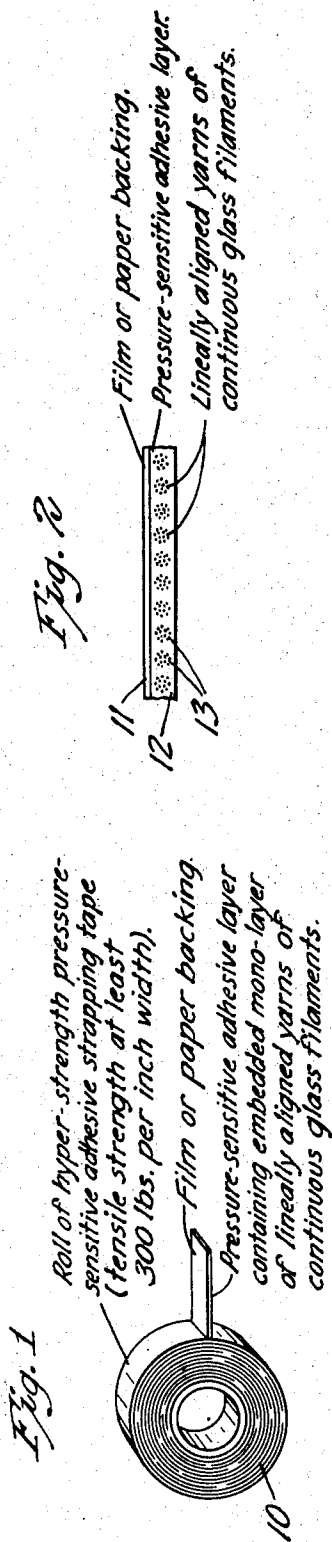
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HYPER-STRENGTH PRESSURE-SENSITIVE ADHESIVE STRAPPING TAPE

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HYPER-STRENGTH PRESSURE-SENSITIVE ADHESIVE STRAPPING TAPE

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This invention is a hyper-strength, flexible, pressure-sensitive adhesive strapping tape wound upon itself in roll form. It is especially intended for heavy-duty industrial use as a replacement for steel straps and wires for many usages in strapping heavy and bulky articles, such as bundles of steel rods and heavy shipping cartons.

This strapping tape has a lengthwise tensile strength of at least 300 lbs./in. (pounds per inch width). Tapes having a tensile strength of the order of 500 lbs./in., and even higher, are made possible by this invention, without sacrifice of other necessary and desirable features. This tape maintains substantially its full strapping strength even when immersed in water for long periods. It has a very high crosswise tear strength and cannot be torn crosswise between the fingers, but it can be readily severed with a knife or scissors. It is highly flexible as indicated by the fact that it can be folded lengthwise upon itself and tightly creased by finger action. It is relatively quite thin considering its strength, having a thickness in the range of 5 to 20 mils. A film-backed tape having a tensile strength of 500 lbs./in. can be made which is only 10 mils thick (total caliper thickness of a hundredth of an inch).

This tape has a film or paper backing coated on the inner face with an aggressively tacky rubber-resin type pressure-sensitive adhesive which contains a completely embedded monolayer of loosely-twisted or non-twisted yarns of continuous hairlike glass filaments that extend continuously from one end of the tape to the other. The glass-filament yarns are lineally aligned, running lengthwise of the tape in contiguous and parallel relation. The yarns lie in a single layer, which can be closely spaced so that the yarns are substantially in shoulder-to-shoulder relation, or can be spaced apart so that the yarn density (number of "ends" per inch width) is substantially less than the possible maximum. The filamentary layer is completely impregnated by the adhesive so that each filament is encased by and adhesively bonded to the tacky and elastic adhesive layer in which the filaments are submerged.

The glass filaments are sufficient in size and number to provide a filamentary adhesive layer having substantially the lengthwise tensile strength specified for the tape. The lengthwise tensile strength and crosswise tear strength of the tape are mainly due to said glass filaments. In contradistinction, the crosswise tensile strength and lengthwise tear strength of the tape are nearly the same as that of the film or paper backing sheet per se.

This adhesive tape is stably and aggressively tacky and upon unwinding from the roll and application to the work it adheres instantly and firmly upon mere contact, without use of water, solvents or heat. The pressure-sensitive adhesive is of the rubber-resin type and is therefore waterproof and elastic. It is eucohesive, being more cohesive than adhesive, and hence the tape can be unwound, handled with the fingers, and stripped from

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smooth surfaces, without leaving an adhesive residue or gumming the fingers.

This strapping tape is adapted for heavy-duty industrial use for many usages which had previously required the use of steel straps (or wires or ropes) and with important attendant advantages. It has value in numerous instances for strapping bundles of steel rods, pipes, lumber, doors, metal roofing, plate glass, etc., and for strapping together the turns of coils of heavy wire, cable, tubing, chains, etc., for shipment, storage and handling. It can be used for strapping together heavy cartons, boxes and cans to facilitate unitized handling, as in palleting operations. It can be used for sealing and reinforcing paperboard cartons containing heavy materials to provide the strength and protection needed for export shipments. A feature in this connection is that the cartons can be sealed so that they cannot be opened and resealed without leaving a tell-tale indication of the tampering, thereby discouraging pilfering. The stripping off of the tape from paperboard cartons pulls away the surface paper not only under but adjacent to the tape, serving to indicate unauthorized removal. The only other manner of opening is by severing the tape.

The use of transparent film backings and of transparent adhesive coatings permit of making a strapping tape which is sufficiently transparent so that it can be applied to surfaces without markedly interfering with the visibility of underlying markings and colorations, and hence such transparent tape can be employed on shipping cartons without being conspicuous or concealing imprinted information. This is possible even though the tape has a tensile strength of 500 lbs./in. or even higher. Transparent backing films also permit of using a colored coating or printing upon the inner face of the backing, or a colored adhesive layer, or a combination of both, which will be visible through and protected by the backing. This is a valuable feature in providing identifying, coding or marking information, or a decorative appearance. Further advantages of film backings are that they are highly resistant to scuffing, provide a glossy anti-friction back surface, make for a thinner and more flexible tape, and that types are available which are intrinsically waterproof and moistureproof.

From the foregoing it will be evident that this hyper-strength adhesive strapping tape has numerous advantages over steel straps, wires, ropes, etc. Long continuous lengths are made convenient to carry about and handle by being wound in compact roll form. For instance, 72 yards of 500 lbs./in. strength tape having a caliper of 10 mils, can be wound on a 3 in. dia. core to provide a roll having an outside diameter of approximately 7 in. The tape is easy to apply and is self-holding. It can be unrolled directly onto the material involved by a simple one-step application procedure using one hand. It has sufficient pliancy and resiliency to permit of tight snug fits. It can be applied around the edges of lumber and wooden articles, and paperboard cartons, without cutting, crushing or breaking down the edges. The adhesive tape strappings cannot slip after application and they prevent or minimize relative shifting of articles bundled together. Strapped bundles can be piled together without the straps of any bundle damaging adjacent bundles by cutting, puncturing, tearing or abrading. The use of this strapping tape avoids injury to workmen since there are no projecting edges or ends and the material cannot cut, prick or scrape the skin.

Each of the glass filaments of the adhesive layer is a continuous, smooth-surface, cylindrical, mono-fiber extending without break from one end of the tape to the

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other (although a small number of the total filaments in any actual tape may have become broken, and one or more of the yarns may have been spliced in connection with replacement of yarn spools in beaming the yarns). The glass filaments employed are extremely fine and hair-like. There are a large number per inch width of the tape and they are distributed across the width of the tape in the form of loosely-twisted or non-twisted contiguous yarns to provide a substantially uniform filamentary layer, thus obtaining maximum thinness and flexibility for the tape and a flat exposed adhesive surface, and minimizing the amount of adhesive required.

Whether the yarns be loosely-twisted or non-twisted, the yarns consist of loose filaments which permit of ready penetration by the adhesive to provide each filament with an encasement of the adhesive throughout its length. When non-twisted yarns are used, the filaments will spread out to a greater extent when the yarns are incorporated in the tape, thereby resulting in a more uniform filamentary layer. However, the use of loosely-twisted yarns has an advantage in that they are easier to handle in preparing warp beams. A twist value on the order of one twist per inch of length has proven to be quite satisfactory.

The tacky rubber-resin type pressure-sensitive adhesive is waterproof, elastic, stretchy, and highly cohesive, as well as being highly tacky. It has the property of wetting glass surfaces, and tightly adhering thereto. Hence the glass filaments require no special treatment or pre-coating in order to insure adhesive bonding to the adhesive, as distinguished from a mere mechanical holding action. The adhesive provides a matrix of such nature that a unitary adhesive and glass filament structure is provided which has properties peculiar to the combination. The effect is combinative rather than merely additive. The tensile strength of the combination layer is substantially greater than that of the glass-filament yarns per se, although the tensile strength of the adhesive per se is negligible. This is an important factor in making possible tapes of very high strength which are thin and flexible.

A disadvantage of glass filaments per se is that they have a relatively low shock strength relative to tensile strength (as compared to various organic filaments). The tough, elastic, permanently tacky, adhesive mass which encases and separates the glass filaments provides a shock-absorbing action when the tape is subjected to sudden yanking or bursting forces, and thus makes feasible the use of glass filaments in adhesive strapping tapes of hyper-strength adapted for heavy-duty uses. This type of adhesive also permits of displacement of the filaments relative to each other and to the backing without slipping relative to the adhesive and without loosening of the adhesive anchorage, owing to the permanently and aggressively tacky nature of the adhesive in contact with the filaments. The elastic nature of the adhesive also tends to oppose displacement stresses and to exert a restoring force. These factors are responsible for obtaining a uniform load distribution as between the various yarns and filaments of the tape when it is stressed.

Another disadvantage of glass filaments per se is that they are not as flexible as many organic filaments and this would be accentuated if they were embedded in a hard or relatively non-stretchy matrix. The present adhesive is highly stretchy and the combinative effect is responsible for the tape having the high flexibility previously noted, which is quite sufficient for the heavy-duty types of adhesive tapes to which this invention relates. The presence of this type of adhesive also makes the filaments less likely to break when the tape is applied around the edge of an object. This is important as glass filaments are more brittle and have poor flex strength as compared to organic textile filaments, as shown by the fact that they cannot be tied into hard knots whereas the latter can be. The present adhesive also prevents the glass filaments from rubbing against each other when the tape is stressed and yet does not prevent relative movement. Since glass will scratch and cut glass, and since a glass filament that has been

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scratched on the surface has very little tensile and flex strength, this protective shielding action of the present adhesive is of very real value to the success of the tape for the purposes intended.

Still another disadvantage of glass filaments per se is their low degree of stretch or elongation. The elongation of glass filaments and yarns is 3% at break when tested in a tensile strength testing machine. The combinative effect of embedding the glass filaments in the tacky rubber-resin adhesive layer of the present tape results in the tape having an elongation of 6% when stretched to the breaking point of the embedded filaments. This is a surprising result. It has been found that this degree of elongation is sufficient for the usages of this tape. This is an important feature of the invention. The lower elongation value of the filaments per se would be inadequate to provide the desired yield and resiliency characteristics.

I have found that the use of glass filaments has very definite advantages in making hyper-strength strapping tapes adapted for heavy-duty industrial usage, as compared to the use of the organic filaments employed in the textile industry. For one thing, it is possible to make tapes of very high tensile strength (500 lbs./in. and higher) which are still relatively thin and flexible owing to the relatively higher tensile strength of glass filaments as compared to viscose filaments, comparing filaments of the same diameter. In this connection it is to be remembered that the yarns are positioned in a mono-layer and must be of relatively small diameter. The organic textile filaments of highest tensile strength are much more expensive and in addition have various undesirable characteristics. For example, nylon filaments show excessive elongation (stretch) which is undesirable for certain uses to which heavy-duty tapes are put because it allows shifting of articles bundled together, etc.

In the case of tapes constructed so as to have a tensile strength substantially lower than 300 lbs./in., the use of organic textile filaments is generally preferable to the use of glass filaments in securing the most desirable combination of properties for the usages of such tapes.

The value of my invention depends upon my discovery that the relative disadvantages of glass filaments changes to a relative advantage in the case of tapes for very heavy-duty use, requiring a tensile strength of at least 300 lbs./in. and which are used for bundling heavy objects, such as steel rods and pipes, and for palleting boxes and drums. It is my discovery that the undesirable characteristics of glass filaments are minimized or made unimportant in such hyper-strength adhesive strapping tapes by virtue of the combinative action of the rubber-resin type pressure-sensitive adhesive layer in which they are embedded, and which simultaneously serves to anchor the tape backing and to permit of adhering the tape to various objects upon mere contact therewith.

In the accompanying drawings:

Fig. 1 shows in perspective a roll of the adhesive tape of this invention;

Fig. 2 is an edge view of the tip of the tape shown in enlarged schematic fashion; and

Fig. 3 is a diagram showing an illustrative system for the continuous manufacture of the tape.

Referring to Fig. 1, there is shown a roll 10 of the hyper-strength pressure-sensitive adhesive strapping tape wound directly upon itself, the adhesive side being on the inside. As the legends indicate, this tape has a tensile strength of at least 300 lbs. per inch width and comprises a film or paper backing carrying on its inner face a layer of pressure-sensitive adhesive containing an embedded mono-layer of lineally aligned yarns of continuous glass filaments.

Fig. 2 shows in more detail the structure of the strapping tape. This tape has a film or paper backing 11 coated on the inner face with a pressure-sensitive adhesive layer 12. The backing can be pre-coated with a primer when it is desired to obtain a higher bond strength

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between the adhesive layer and the backing. Embedded within the adhesive layer is a mono-layer of contiguous yarns 13, formed of hair-like continuous glass filaments, the tips of which are exposed to view in the drawing. These yarns run lengthwise of the tape and are parallel to each other and to the backing and to the smooth (flat) surface of the adhesive layer, and are referred to as being aligned. They are layed down in a mono-layer (a layer having a thickness of one yarn) with adjacent yarns nearly touching each other (i. e. approaching to a shoulder-to-shoulder relation), although a wider spacing can be used, depending upon the number of "ends" per inch width that are employed. Each yarn consists of a large number of continuous mono-fiber filaments twisted together. A loosely-twisted yarn is used, as distinguished from a tightly twisted yarn or thread, so as to facilitate adhesive penetration. Thus a twist value on the order of one twist per inch is suitable. Each yarn is completely encased by the pressure-sensitive adhesive, which penetrates between the yarns. The adhesive penetrates into the yarns and impregnates them so that the individual filaments are bonded together and thereby unified by the pressure-sensitive adhesive.

Referring to Fig. 3, there is shown an illustrative continuous system for making the adhesive tape. The backing sheeting has been given a preliminary coating of pressure-sensitive adhesive, amounting to about one-third of the adhesive coating weight of the final product, in a previous operation (not shown), and this pre-coated backing sheeting provides the starting material for the operations shown in the drawing. Briefly stated, the pre-coated backing sheeting is drawn from a supply roll thereof and passes through the nip of a pair of horizontal laminating rolls, tacky side up, at which point a mono-layer of aligned glass-filament yarns is pressed against the adhesive surface and becomes adhered thereto so that the yarns are retained in position. The sheeting is then coated with a pressure-sensitive adhesive solution which impregnates and covers the yarn layer, and is drawn through an oven to fully remove the solvent and dry the adhesive, after which it is wound in a jumbo roll. This adhesive sheeting can then be slit into desired widths and wound into adhesive tape rolls of desired length, ready for use and sale.

The following is a more detailed description.

The film or paper backing sheeting, pre-coated with a dried pressure-sensitive adhesive, is continuously withdrawn from supply roll 14 (provided with a tensioning brake, not shown) and passes under guide roll 15 so as to be in a smooth, unwrinkled condition, and then passes upwardly to and over guide roll 16. The coated sheeting, adhesive side up, is then drawn horizontally to and through the nip of horizontal laminating rolls 17 and 18. The lower roll, 17, is rubber-covered and the upper roll, 18, has a rigid steel surface. These rolls have a diameter of about six inches. It is here that the glass-filament yarns are laminated to the adhesive-coated sheeting.

The yarns are drawn from warp beams (not shown) located above each other in a tier. The "sheets" of yarns 19 are shown coming in from the left to the condensing comb device 20, which is shown schematically as these combing devices are well known in the textile industry. Here the yarns from the warp beams are interfitting to form a single layer of contiguous yarns of the necessary density (number of "ends" per inch width). For example, suppose it is desired to form a yarn layer consisting of 100 "ends" per inch, this layer to be 36 inches wide for laminating to the adhesive-coated sheet. Using warp beams which each have 600 yarns over a 54 inch width, a total of six beams are used, thus providing 3600 yarns. The six "sheets" of yarns are combined at the condensing comb (as illustrated in the drawing) and the width reduced from 54 to 36 inches, thereby securing the desired density of 100 yarns per inch width. The layer of yarns is drawn down over a one inch diameter

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steel doctor rod 21 and then under and around a similar doctor rod 22, and then up to and around the upper laminating roll 18, which rotates in a counter-clockwise direction, meeting the adhesive-coated backing at the nip.

The layer of yarns is pressed against the surface of the tacky adhesive coating in going through the nip of the laminating rolls, to form a lineally aligned mono-layer of yarns which are held in place by the tackiness of the adhesive.

The laminated sheeting proceeds horizontally, yarn side up, to the coating device 23 having a support roller 24 over which the sheeting passes below a spaced doctor blade 25 behind which the adhesive solution 26 is fed, thereby spreading on the second coating of pressure-sensitive adhesive solution in an amount equal to about two-thirds of the total adhesive coating weight (dry solids basis). The total adhesive coating is such that the layer of yarns is fully saturated and embedded within it and a smooth (flat) adhesive surface is obtained.

The fully coated sheeting is then drawn into the upper part of drying oven 27, where it passes back to guide roll 28, then down to the guide roll 29 near the bottom, then forwardly to guide roll 30, up to guide roll 31, back to guide roll 32, up to guide roll 33 and then forwardly to and over guide roll 34 and out of the oven.

The dried adhesive sheeting then passes over roll 35, down under guide roll 36, and over the top of driven pull drum 37. This pull drum contacts the tacky, adhesive surface of the sheeting and exerts a pull which is responsible for drawing the backing sheeting through the entire system from its supply roll, and for drawing the yarns to the laminating rolls from the section beams. The adhesive sheeting passes from the pull drum to and under guide roll 38 to a wind-up machine where it is wound into jumbo roll 39, thus completing the manufacturing process except for the conventional subsequent slitting and tape roll winding operations.

Further mention will now be made of the various materials which can be employed in making the present adhesive strapping tape.

The backings fall into two groups: non-fibrous film sheeting, including metal foils as well as organic polymer films; and paper (flat or creped) which has been unified and rendered water-resistant by treating, coating or impregnation.

Cellulose acetate films are well suited for use as non-fibrous film backings for the present tape, and have an advantage over cellophane in being resistant to prolonged contact with water. Other cellulosic films are well known but are more expensive. The backing film can be given a microthin coating of a low-adhesion polymeric compound on the back face so as to reduce the force required for unwinding the adhesive tape from a roll. Cellulose tristearate, tripalmitate, and trilaurate are examples of such compounds, and will provide the back surface with an adherency to the pressure-sensitive adhesive which is less than that of a base film of cellulose acetate or cellophane. Examples of non-cellulosic films are the various vinyl polymer films, polyethylene films, rubber hydrochloride films, etc. These films are all obtainable as clear transparent film sheeting adapted for making transparent strapping tapes.

The fibrous paper tapes of backings may be of the kinds heretofore employed in the making of paper-backed pressure-sensitive adhesive tapes. These are generally bibulous kraft or rope papers which have been unified by impregnation with a flexible water-insoluble rubbery composition adapted to render the paper water-resistant and to bind the fibers together so as to prevent splitting or delamination of the paper under the strong force exerted upon the paper when aggressively tacky tape is unwound from rolls thereof. Creped paper, such as kraft towelling paper, is commonly used for making backings for masking tape, as this provides increased stretchability. Such unified backings are commonly backsized with a thin

coating of material (such as shellac, a cellulosic lacquer, or an alkyd resin) which reduces the force required for unwinding the tape. For detailed information on the making of illustrative unified paper tape backings reference may be made to U. S. Patents Nos. 2,236,527—2,410,078—2,410,089 and 2,438,195. An impregnated paper backing is not essential. Thus chemical treatment may have been employed to unify the fibers, as with parchmientized paper. Or a dense, highly calendered paper may be used, having a coating or coatings on the exposed back surface to cover the fibers and reduce the force required for unwinding the tape, the natural interbonding of the fibers then being sufficient to provide a unified paper backing that will not delaminate. The term "paper" as herein used embraces not only true paper but equivalent non-woven fibrous sheetings formed of intermeshed or felted fibers.

The adhesive can be one of the various rubber-resin type pressure-sensitive tape adhesives, well known in the art, which are water-insoluble and aggressively tacky. These adhesives have a rubbery base of natural or synthetic rubber which provides cohesion (internal strength) and elasticity (a retractive force when stretched and retraction when released after stretching); and this rubber base is modified by blending with a compatible tackifier resin (such as rosin or ester gum) which serves to increase adhesion (tackiness) and decrease cohesion, with an attendant increase of stretchiness (elongation under low stresses) and decrease of elasticity. These rubber-resin tape adhesives have a proper four-fold balance of adhesion, cohesion, stretchiness and elasticity, which permits adhesive tape coated therewith to be aggressively and stably tacky and yet be capable of being stripped back from smooth surfaces to which temporarily applied without delamination or offsetting of adhesive, even though the adhesive has been coated directly upon a smooth non-fibrous film backing (such as cellophane) and has no mechanical anchorage thereto. These tape adhesives are termed "eucohesive" by which it is meant that they are more cohesive than adhesive such that offsetting or transfer of adhesive material does not result when the tape coated therewith is unwound from rolls or removed from surfaces to which temporarily applied, and the tape can be handled without transfer of adhesive material to the fingers. Certain synthetic polymers are inherently tacky and eucohesive and possess the above-mentioned four-fold balance of properties, and can be used as pressure-sensitive tape adhesives, thus being equivalents of the rubber-resin adhesives and hence they may be regarded as being of the rubber-resin type. An example is a 75:25 copolymer of 2-ethyl-butyl-acrylate and ethyl acrylate.

The rubbery bases used include crude natural rubber, Buna-S type synthetic rubber, and polyisobutylene (Vistanex). The tackifier resins include rosin, ester gum, pure hydrocarbon terpene resin of 115° C. melting point ("Piccolyte"), and hydrogenated indene-coumarone resin of 150° C. melting point ("Nevillite resin"). Zinc oxide can be included as an opacifying and reinforcing pigment when transparency is not needed. Carbon black can be included to give a black color, and titanium dioxide pigment to give a brilliant white color. Various chromatic pigments can be included to produce desired colors. For present purposes a highly aggressive tack is desired and can be obtained by using about 75 to 125 parts of tackifier resin per 100 parts of rubber. A suitable proportion of zinc oxide, when used, is about 50 to 75 parts per 100 parts rubber, and it is combined with the rubber by milling together, as is the case when other pigments are to be incorporated. The adhesive is prepared for coating by churning together the rubber (cut into pieces) and the resin in a volatile hydrocarbon solvent (such as heptane) present in proportion to impart a suitable coating viscosity.

A preferred type of glass-filament yarn for present

purposes is designated in the trade as "150 1/0 1.0Z," which signifies that the yarn weight is 15,000 yards per pound (which corresponds to a denier value of approximately 300), that it consists of a single twisted strand, that there are 1.0 turns per inch to the twist, and that the twist is in the "Z" direction. The average diameter of the individual filaments is 0.38 mil (0.00038 in.). The nominal minimum breaking strength is rated as 2.6 pounds per yarn. The average number of filaments in a yarn is 105. Because of the loose twist, the yarn can be readily penetrated by the adhesive so as to thoroughly impregnate the yarn and encase each filament. As the glass filaments do not touch each other in the adhesive tape product, and as the yarn can somewhat flatten out when fed into the tape structure under tension, the apparent width of each yarn, as viewed in the tape product, will vary somewhat depending upon the making procedure. When a yarn density of 100 "ends" per inch width is employed, the yarns will be closely spaced, approaching a shoulder-to-shoulder relation. When 50 "ends" per inch are used, the yarns will apparently occupy substantially more than one-half of the total width of the tape, as there has been more opportunity for them to flatten out to an oval cross-section and thus reduce the average spacing distance between contiguous yarns.

A tape having a cellulose acetate film backing and 100 yarn "ends" per inch width will have a lengthwise tensile strength of about 550 lbs./in., despite the fact that the backing per se and the adhesive per se possess but little tensile strength in comparison. Reducing the number of yarn ends per inch to 50 reduces the lengthwise tensile strength of the tape to about 300 lbs./in. Thus the strength per yarn end is about 5½ to 6 lbs. The increase in effective strength per yarn is very substantial and is the result of the combinative effect of the pressure-sensitive adhesive in which the yarn is embedded and with which it is impregnated. A layer of non-reinforced adhesive can be quite easily pulled out between the fingers to the breaking point, which shows that its tensile strength per se is negligible in comparison to that of the yarn-reinforced adhesive layer.

Continuous glass filaments do not adhere to rubber and when encased in rubber can be pulled out, being smooth-surfaced cylinders held only by friction. This is in contrast to natural fibers. In the present product the glass filaments require no special treatment in order to be firmly bonded, owing to the fact that the tacky rubber-resin type adhesive, unlike rubber per se, wets the glass fiber surfaces and has a strong specific adhesion to them. Glass-filament yarns are commonly supplied with a starch or oil sizing on the filaments to facilitate handling in textile manufacturing operations. The presence of such a sizing on the filaments does not interfere with the obtaining of a strong adhesive bonding between the rubber-resin adhesive and the glass surfaces of the filaments, as it is absorbed or penetrated by the adhesive during fabrication of the adhesive tape. The adhesive bond is not broken by the movement of the filaments inasmuch as the adhesive is very stretchy and is permanently tacky. The wetting action of this type of adhesive also facilitates its penetration between the filaments so as to thoroughly contact their surfaces.

Although not necessary, the glass filament yarns can, if desired, be given a special treatment prior to incorporation in the adhesive so as to modify their properties. Thus a physical or chemical treatment, or a washing, or the application of a surface coating or sizing, may be employed, if desired.

The following example gives an idea of the amazing strength that can be obtained.

Example

This transparent strapping tape had the structure shown in Fig. 2. It had a transparent cellulose acetate film backing of 1.5 mils thickness. The thickness of the pressure-sensitive adhesive layer was 8.5 mils, the total

caliper thickness of the tape thus being 10.0 mils. The glass-filament yarn layer consisted of a mono-layer of contiguous yarns numbering 96 per inch width (i. e., 96 "ends" per inch). The yarns were of the "150 1/0 1.0Z" type previously mentioned. A transparent rubber-resin pressure-sensitive adhesive was used and the tape as a whole was transparent in the sense that it could be applied to surfaces without obscuring the colorings and markings. The adhesive transparentizes the yarns as it surrounds and fully impregnates them and has approximately the same refractive index as the glass.

This strapping tape had a lengthwise tensile strength of 540 lbs. per inch width and an elongation at break of 6%. The crosswise tensile strength was about 15 lbs. per inch "width" of the tested piece of tape, and the crosswise elongation at break of the backing film was about 5%.

The lengthwise tensile strength was determined by doubling the value measured for a 1/2 in. width tape, which was measured on a Scott Tensile Tester, Model J-5 (screw driven jaw separation), the lower jaw moving at 12 inches per minute.

The lengthwise tear strength was comparable to that of the acetate film backing per se, the tape being easily torn with the fingers. The crosswise tear strength was extremely high and the tape could not be torn with the fingers, since this tear direction is across the glass yarns.

This illustrates that the backing and yarns are such that the lengthwise tensile strength and crosswise tear strength of this tape are mainly due to the presence of the glass-filament yarns, and the crosswise tensile strength and lengthwise tear strength are mainly due to the presence of the backing.

I claim:

1. A hyper-strength pressure-sensitive adhesive strapping tape wound upon itself in roll form and adapted for strapping heavy and bulky objects such as bundles of steel rods and heavy shipping cartons, comprising a thin flexible backing sheet of the class consisting of films and unified papers, an aggressively tacky rubber-resin type pressure-sensitive adhesive layer bonded to the inner face of the backing and having a smooth flat outer surface, and a non-woven mono-layer of lineally aligned glass-filament yarns fully embedded in the adhesive layer, the yarns consisting of loose hair-like continuous glass filaments which are individually encased by the tacky adhesive and which are sufficient in number when in combination with the adhesive to impart a lengthwise tensile strength to the tape of at least 300 pounds per inch width, the filamentary adhesive layer being highly flexible to permit the tape to be folded lengthwise upon itself and tightly creased by finger action; the lengthwise tensile strength and crosswise

tear strength of the tape being mainly due to the presence of said glass filaments, and the crosswise tensile strength and lengthwise tear strength of the tape being mainly due to the presence of said backing.

2. An adhesive strapping tape according to the preceding claim which has a lengthwise tensile strength of the order of 500 pounds per inch width and a caliper thickness of the order of 10 mils.

3. A hyper-strength pressure-sensitive adhesive strapping tape wound upon itself in roll form and comprised of a thin flexible waterproof non-fibrous film backing, an aggressively tacky rubber-resin type pressure-sensitive adhesive layer bonded to the inner face of the film backing and having a smooth flat outer surface, and a non-woven mono-layer of lineally aligned glass-filament yarns fully embedded in the adhesive layer, the yarns consisting of loose hair-like continuous glass filaments which are individually encased by the tacky adhesive and which are sufficient in number when in combination with the adhesive to impart a lengthwise tensile strength to the tape of at least 300 pounds per inch width, the filamentary adhesive layer being highly flexible to permit the tape to be folded lengthwise upon itself and tightly creased by finger action.

4. An adhesive strapping tape according to claim 3 which has a lengthwise tensile strength of the order of 500 pounds per inch width and a caliper thickness of the order of 10 mils.

5. An adhesive strapping tape according to claim 3 wherein the backing film and the adhesive are transparent and the composite tape is sufficiently transparent so that it can be applied to surfaces without obscuring underlying markings and colorations.

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