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[54] **PAPER TUBE ADHESIVE AND PAPER TUBE**

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[58] **Field of Search** ..... 156/184, 190, 195, 325; 428/35, 222; 138/144, 154; 106/286; 93/80, 81 R, 94 R

[56] **References Cited**

UNITED STATES PATENTS

1,253,371	1/1918	Gill	156/195 X
2,434,465	1/1948	Marc	156/325
2,888,043	5/1959	Reid	156/195 X

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[57] **ABSTRACT**

Paper tube adhesive for use in manufacturing convolute and spiral paper tubes of greater structural strength and bulk weight. The adhesive comprises a mixture of sodium silicate, solvent and calcium carbonate.

2 Claims, No Drawings

PAPER TUBE ADHESIVE AND PAPER TUBE

The present invention relates to a new adhesive to be used in the manufacture of paper tubes and the paper tubes resulting therefrom.

In order to appreciate the advantages inherent in this adhesive, it is necessary to understand certain factors involved in the manufacture of paper tubes. Paper as manufactured on modern machines has a grain, that is, it is stronger in one direction than in the other. Paper grain is analogous to the grain in wood. The greatest strength of the paper is with the grain, the lesser strength across the grain. The grain in paper runs in the machine direction. As paper is produced with a modern paper machine, the paper moves from the machine continuously and is wound on a rotating take-up roll. The grain is in the direction of rotational motion of the roll, so that after the roll is formed, the grain of the paper is perpendicular to the axis of the roll. If a sheet of paper is drawn from the roll, it can be wound on a mandril in either of two directions to form a paper tube; (1) with the grain perpendicular to the axis of the mandril as it is on the original roll, or (2) with the grain parallel to the axis of the mandril by, in effect, winding the paper across the roll. If the tube is wound with the grain perpendicular to the axis of the mandril it will have a very high crush strength but very little beam strength. If on the other hand the tube is wound with the grain parallel to the axis of the mandril, it will have a high beam strength but a low crush strength. Convolute tubes are wound with the grain parallel to the axis of the mandril. Otherwise the length of the convolute tube would be the same as the width of the roll, or a portion of this width; and the ultimate length of the tube would be dependent upon the width of the paper as produced by the machine. In addition the convolute tube when wound with the grain perpendicular to the axis of the mandril, would not have sufficient beam strength to be of general use. By winding with the grain parallel to the axis of the mandril, the only limitation on the length of the convolute tube is the length of the mandril itself. The wall thickness of the tube can be adjusted by varying the number of turns and the thickness of the paper used. The thickness of the paper used is usually adjusted so that the desired wall is secured using the full width of the roll.

Spiral tubes are wound from ribbons which are slit from the supply roll so that the grain of the paper again is perpendicular to the axis of the tube roll. The ribbons are wound around the mandril at such an angle that their edges are in abutment, and each ribbon forms a continuous layer, or ply, within the wall of the tube, and will contribute its thickness to that wall. The actual angle will be determined by the width of the ribbon and the diameter of the mandril. It is normal for such spiral tubes to be wound at angles between 25° and 45°. When the ribbons are wound into the tube, the seams are staggered so that no one seam lies directly over another. This arrangement is necessary to maintain the strength of the tube. In such a tube the grain of the paper is neither parallel to the axis, or perpendicular to the axis of the mandril, but lies somewhere between the two, depending upon the angle at which the ribbons are wound on the mandril. Such a tube normally has high crush strength and low beam strength.

Most adhesives now in use do not contribute significantly to the strength of the tube although silicate of soda is slightly better than the starches and dextrines.

The reason such additional strength is not secured through use of these adhesives is due to the fact that a very thin glue line must be used in order to obtain proper adhesion, and to prevent crazing or powdering of the glue line after the glue has dried.

It is an object of the present invention to improve the crush strength of such paper tubes.

According to the present invention, it has been discovered that an adhesive mixture comprising the combination of silicate of soda, water and calcium carbonate increases the crush strength of the paper tube while also increasing the bulk weight of the paper tube. The preferred source of calcium carbonate is ground marble or ground limestone of approximately a number 9 grade. The particle size of the calcium carbonate is not critical; it is only necessary that the carbonate be sufficiently fine in texture to be easily mixed with and suspended within the silicate of soda.

It has been determined that a suitable paper tube adhesive is obtained when the mixture contains between 10 and 40% by weight calcium carbonate and 2½ to 7½ percent by weight solvent and the remainder sodium silicate. The percentages are based on the total weight of the mixture. In a preferred embodiment the adhesive mixture contains from 25% to 35% by weight calcium carbonate and 3% to 5% by weight solvent and the remainder sodium silicate. The preferred solvent in this embodiment is water but it should be understood that other materials which will carry or dilute the active ingredients may be used.

The calcium carbonate powder is suspended in the silicate of soda and kept suspended by constant agitation until the mixture is applied to the paper. We have found this best accomplished by combining the calcium carbonate, silicate of soda, and solvent in a mixing tank, provided with an agitator, for a sufficient length of time to produce a smooth blend. The mixing tank is piped to the adhesive pan on the tube rolling machine such as a convolute tube rolling machine. The pipe is provided with a valve, so that upon opening the valve, the mix flows to the adhesive pan by gravity or other means. The adhesive pan on the machine is also provided with agitators so that the mixture is constantly agitated. The glue roll applicator on the tube rolling machine is partially submerged in the agitated mixture and transfers the mixture from the pan to the surface of the paper, thus calcium carbonate is properly suspended within the mixture when it is deposited on the paper.

An interpretation of the action of the two major ingredients is as follows. The individual particles of the calcium carbonate are coated with the silicate of soda and there is some absorbtion of the silicate of soda into the calcium carbonate. When the mixture is pressed between two layers of paper the excess silicate of soda is absorbed into the pores of the paper. Due to the relative size of the calcium carbonate particles they can not enter into the pores of the paper, but must remain between the two layers of paper. Each particle, however, retains a thin coating of silicate of soda and the laminating pressure causes these particles to adhere to each other and to the paper. Thus, there is obtained a substantial layer of adhesive between the two sheets of paper. This layer of adhesive consists of layers of calcium carbonate particles and silicate of soda, the silicate of soda being compressed between the particles of calcium carbonate so that no layer of silicate is of greater thickness than its molecular size, a condition

which is necessary to prevent crazing. The resulting cement of calcium carbonate and silicate of soda has high crush strength and contributes substantially to the crush strength of the finished paper tube. As we stated before, a small amount of solvent is added to the mixture. This solvent promotes more rapid absorbtion of the silicate of soda into the paper expediting curing and drying of the tube. It could be said that the added solvent reduces the viscosity of the silicate of soda and causes it to be more rapidly absorbed by the pores of the paper. The evidence obtained is that the calcium carbonate absorbs solvent from the silicate of soda and tends to make the silicate dry more rapidly thereby inhibiting proper flow of the adhesive during the winding operation. This inhibition of proper flow can be prevented and controlled by the addition of the small amount of solvent. The resulting paper tube has a much higher crush strength than one made with silicate of soda only.

Our adhesive has another major advantage in the winding of spiral tubes. A spiral tube machine consists essentially of a mandril and a moving rubber belt. The rubber belt has a width the same as, or slightly less than, the paper ribbons which are being wound into the spiral tube. The rubber belt makes a turn around the mandril at the desired angle to wind the ribbon. When the belt is driven, it draws the plies of ribbons of paper around the mandril, moving them forward at the same time. Thus, the plies are drawn under the belt, compressed together, and leave the belt a completed spiral tube, although at this time the adhesive is not completely set. The grip of the belt on the outer ply of paper provides the traction force, but this force must be transferred from ply to ply down through the tube so that all the ribbons are drawn in at the proper rate. However, the plies are separated by a layer of adhesive and to a certain extent, this adhesive will act as a lubricant, so there is a tendency for one ply to slip on the other until such a time as the adhesive is completely set. This slipping action limits the speed at which a spiral tube machine can be operated, and limits the amount of adhesive which can be applied to the various plies of paper. Silicate of soda is particularly bad in this respect, and tubes being wound of silicate of soda have a tendency to slip under the belt. The addition of calcium carbonate to the silicate of soda produces two advantages. The calcium carbonate particles tend to bite into both layers of paper, providing a gritty and abrasive contact surface which substantially reduces slippage, and the drying action of the calcium carbonate produces a faster set for the adhesive, both of which permit the machine to operate at a higher speed.

The following example is presented as a further illustration of the present invention.

EXAMPLE

A convolute tube is prepared in standard fashion using conventional paper as a source of construction

material and a conventional convolute tube winding machine modified to provide adequate agitation to the adhesive mixture prior to and during application of the adhesive mixture to the paper. An adhesive mixture of 64% sodium silicate, 32% calcium carbonate and 4% water is prepared and employed during the winding of a convolute paper tube. The resulting product is found to have improved crush strength and increased bulk weight over a similarly prepared paper tube using only sodium silicate as the adhesive.

One of the major advantages in the use of this mixture is the reduction in costs. Paper costs approximately ten cents a pound, silicate of soda costs two cents a pound and calcium carbonate one cent a pound. When combined as stated in the example, the cost of the adhesive mixture is approximately one and one-half cents per pound. Since convolute tubes are sold by weight, it is possible to replace a certain amount of paper, costing ten cents a pound, with an adhesive mixture costing one and one-half cents per pound, and still manufacture a tube of equal, or greater strength. Thus, a substantial reduction in cost is achieved. In the alternative, the same amount of paper may be used, and a paper tube of greater weight and greater strength is obtained.

Sodium silicate adhesive is normally sold to customers as a solution of sodium silicate dissolved or dispersed within a carrying medium or solvent such as water. The resultant solution or mixture is customarily referred to as sodium silicate adhesive. When the term sodium silicate or silicate of soda is used in this application, reference is being made to that mixture or solution of sodium silicate which is customarily sold as the adhesive. Such an adhesive normally contains from 35% to 70% by weight of carrying medium or solvent such as water. The amount of solvent referred to in this application is in addition to that solvent present in the sodium silicate adhesive solution.

While this invention has been described in detail, with particular reference to preferred embodiments thereof, it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described in the appended claims.

I claim:

1. Paper tube adhesive consisting essentially of a mixture of from 10 to 40% by weight calcium carbonate, and the remainder sodium silicate and solvent, the percentages being based upon the total weight of the mixture.

2. A cylindrical paper tube comprising at least one layer of wound paper having at least one overlapping edge and a discrete layer of paper tube adhesive between the overlapping edges of the paper, said adhesive comprising a mixture of from 10 to 40% by weight calcium carbonate, and the remainder sodium silicate and solvent, the percentages being based upon the total weight of the adhesive mixture.

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