

Oct. 10, 1961

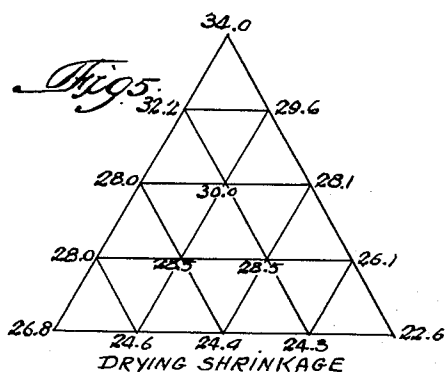
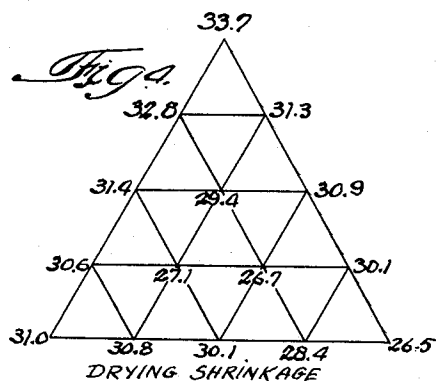
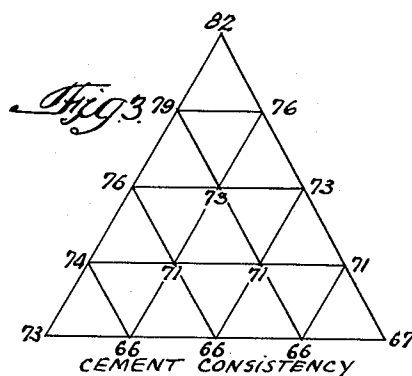
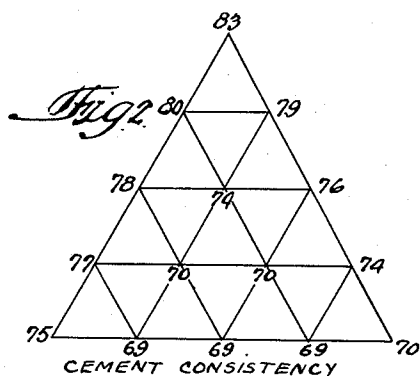
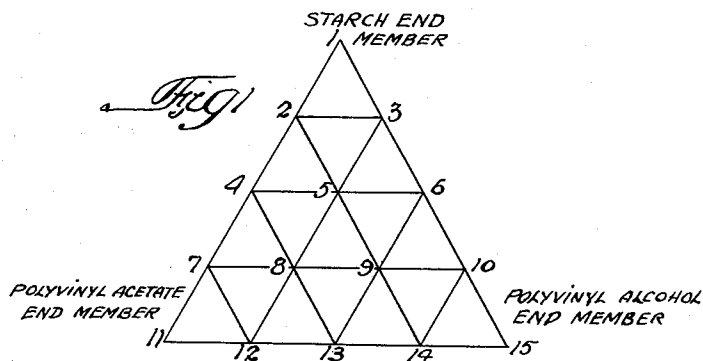
M. P. PTASIENSKI ET AL

3,003,979

DRY CEMENT COMPOSITION COMPRISING CELLULOSIC THICKENER
GELLED STARCH, POLYVINYL ALCOHOL AND POLYVINYL ACETATE

Filed Dec. 5, 1958

2 Sheets-Sheet 1



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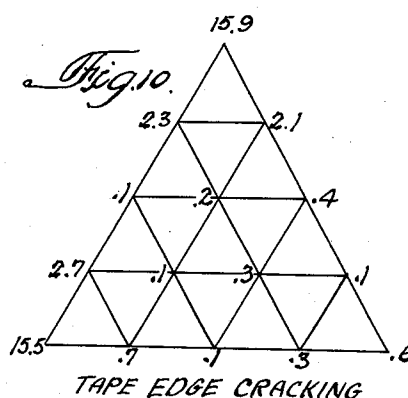
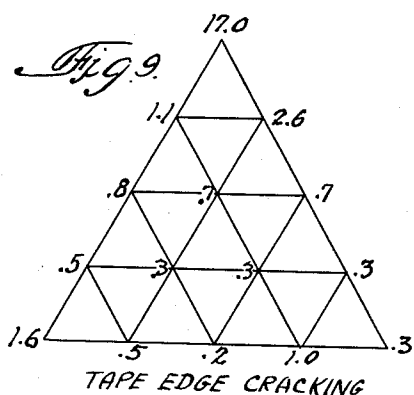
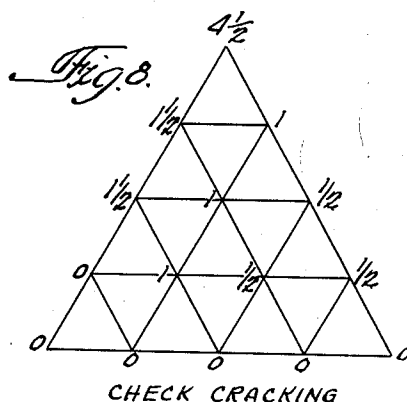
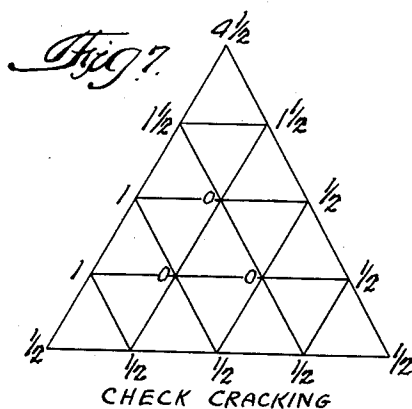
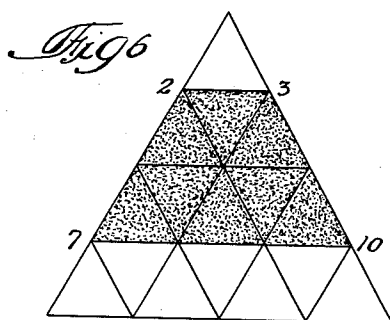
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2 Sheets-Sheet 2



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3,003,979

DRY CEMENT COMPOSITION COMPRISING CELLULOSE THICKENER GELLED STARCH, POLY-VINYL ALCOHOL AND POLYVINYL ACETATE

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11 Claims. (Cl. 260-17)

This invention pertains to an adhesive composition and more particularly relates to compositions commonly known as joint cements.

Dry-wall construction has become increasingly popular over the years until at the present time it is estimated that over fifty percent of the new residences constructed are finished with dry-wall. In the usual dry-wall construction, gypsum wallboard panels are nailed or otherwise fastened in a single or double layer to supporting framing members. The wallboards have paper covers which form the finished wall surfaces to be decorated by painting or the like.

The exposed wallboard surfaces usually have the joints between abutting wallboards concealed to form a finished wall of smooth monolithic appearance. Previously, the joints were covered by narrow wood strips or by cementing cloth, metal, or paper tapes disposed over the joints. As the dry-wall industry developed, it later became the practice to embed a perforated paper tape in a filled aqueous adhesive over the joints and to apply additional adhesive coats thereover until a desired smooth-surface appearance was effected. This general system of construction is described in such prior patents as Page Patent No. 2,047,982, Page and Southwick Patent No. 2,180,433, and Gill and Southwick Patent No. 2,749,267.

The growth of the dry-wall industry and the steadily increasing public acceptance of dry-wall construction have not been unattended by problems. One such problem relates to a phenomenon called in the trade "edge-cracking." As the name suggests, edge-cracking is the development of a crack in the joint cement at or near the edge of the tape. The crack apparently occurs as a result of differential movement of the tape, the cement, and the face of the board during drying of the cement. In some instances movement of the framing members may also be a factor.

Job conditions and cement compositions have an important bearing on the incidence of edge-cracking. The protein-bound cements of the so-called high alkaline type (wet mix pH above about 12) in which lime plus some sodium salts are the primary protein solvent, were quite susceptible to this defect. When the medium and low alkaline type cements became generally prevalent in the late 1940's, a significant improvement in this condition was experienced. These latter cements relied primarily on sodium or ammonium salts as protein solvents.

Job conditions particularly conducive to edge-cracking are those of low humidity at moderate to high temperatures. In new work these occur most frequently in the more arid sections of the country but can occur anywhere in repair and remodel work in heated buildings. Unfavorable job practices also contribute to this defect. Of these, over-thinning of the cement is probably the major factor. This trend has been abetted recently by the introduction of automatic tools for cement and tape application. For example, for hand trowel or broad-

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knife application cement viscosity will be typically in the range of 250 to 500 Brabender units. In some of these newer tools, however, cement viscosities will be of the order of 100 Brabender units or less.

The adhesives, or joint cements, in use today are predominantly based on proteins as the primary binders. While casein is the preferred protein, certain refined soy proteins have also found acceptance. Various alkaline materials, known to have a solubilizing effect on proteins when water is added, are included as are preservatives to inhibit bacterial and fungal action on the proteins. Thickeners in minor quantities are often used, of which certain natural gums are typical examples (e.g., the alginates).

The fillers used may be considered standard, as most manufacturers use approximately the same filler combination, chosen to provide the optimum balance in such properties as ease of mixing, proper consistency, application qualities, drying rate, shrinkage and the like. A typical filler combination, in which percentages are based on total cement, can be expressed within the following ranges:

	Percent
Fine ground asbestos.....	5-10
Mica and micaceous fillers.....	10-60
Ground limestone, q.s.....	100

These fillers are equally applicable in the present invention, and choice of fillers thus represents no part of the inventive concept of this invention.

Despite the recited advances made in the suppression of edge-cracking, this latter phenomenon is still a serious problem in the industry. It is obvious that repairing wallboard joints displaying edge-cracking is an expensive and time-consuming operation regardless of the size of the cracks, particularly when the cracking is not observed until after the wall has been decorated.

It is an object of this invention, therefore, to provide a novel dry cement composition which, after mixing with water, is particularly adapted for use in securing joint tape to wallboard with the substantially complete absence of edge-cracking.

It is another object of this invention to provide a joint cement composition which requires no new handling or application techniques and accordingly may be readily employed by persons skilled in the art.

It is a further object of this invention to provide a joint cement which is flexible in composition so that the amounts of the ingredients thereof may be greatly varied in accordance with the ranges hereinafter set forth. The composition flexibility enables the cement to be custom prepared for particular applications, as will hereinafter be explained in greater detail.

It is another object of this invention to provide joint cements employing a novel cold-water soluble cellulose thickener and ternary binder combination and conventional fillers.

The above and other objects of this invention will become more apparent upon proceeding with the following detailed description when read in the light of the accompanying drawing and appended claims.

The dry cement compositions provided by this invention are mixed with sufficient water to provide a desired working consistency. Any dry cement composition formed in accordance with the following Table I will work to advantage.

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TABLE I

		Percent by Weight of Cement
1. Cold-water soluble cellulosic thickener containing only ether and hydroxyl oxygen.		.3-1 4.5-12
2. Binder	Percent of Binder by Weight	
(a) Acid hydrolyzed pre-gelled starch	25-70	Remainder
(b) Water dispersible polyvinyl acetate	3-75	
(c) Cold-water soluble polyvinyl alcohol (about 88% hydrolyzed)	1.5-75	
3. Filler	Percent of Filler by Weight	
(a) Fine ground asbestos	5-10	Remainder
(b) Mica and micaeous fillers	10-60	
(c) Ground limestone	Remainder	
		100%

Quite often a small amount (less than 1%) of a compatible fungicide is desirable as an ingredient in these cements.

For a more complete understanding of this invention reference will hereinafter be made to the drawings wherein:

FIGURE 1 is a triaxial diagram of cement compositions provided by this invention employing a plurality of binder compositions, the cements being identified by the numbers 1 through 15;

FIG. 2 is a triaxial diagram setting forth consistencies of the cements of FIG. 1, including .5% by weight of methyl cellulose;

FIG. 3 is a triaxial diagram similar to that of FIG 2 relating to cements employing .3% by weight of methyl cellulose;

FIG. 4 is a triaxial diagram illustrating the percent of shrinkage on drying of the cement compositions of FIG. 1, including .5% by weight of methyl cellulose;

FIG. 5 is a triaxial diagram similar to that of FIG. 4 relating to cements employing .3% by weight of methyl cellulose;

FIG. 6 is a triaxial diagram in which the shaded portions illustrate the most desirable joint cements for purposes of this invention;

FIG. 7 is a triaxial diagram illustrating the check cracking in cements employing the cements of FIG. 1, including .5% by weight of methyl cellulose;

FIG. 8 is a triaxial diagram similar to that of FIG. 7 relating to cements employing .3% by weight of methyl cellulose;

FIG. 9 is a triaxial diagram illustrating the percent of tape edge length along which cracking occurred in cement compositions of FIG. 1 and .5% by weight of methyl cellulose; and

FIG. 10 is a triaxial diagram similar to that of FIG. 9 relating to cements employing .3% by weight of methyl cellulose.

As stated above, the novel cements provided by this invention employ conventional fillers for cements of this type, a cold-water soluble cellulosic thickener, and a ternary binder. Each of the main ingredients will now be discussed in detail.

Cellulosic thickener

Conventional well known thickeners, such as gum tragacanth, Irish moss, guar gum, etc., will not function properly in the novel cement compositions provided by this invention. The thickeners to be employed are cellulose-based thickeners, and more particularly cold-water soluble grades thereof containing only ether and hydroxyl

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oxygen. The preferred member of such thickeners is methyl cellulose; also satisfactory are hydroxyethyl and ethyl hydroxy-ethyl cellulose, all of which are commercially available. It should be understood that commercial grades of methyl cellulose may be modified to a minor extent with other ether linkages such as hydroxy-propoxy, and the resulting product will function satisfactorily for purposes of this invention.

The higher viscosity cellulose-based thickeners are preferred, and when commercial cold-water soluble grades of methyl cellulose are used, a 4000 centipoise grade is particularly suitable. Lower viscosity grades, as, for example, within a range of 20-400 centipoises, may be employed; however, greater quantities of the low viscosity grades must be employed. It has been found that it is more economical to use the higher viscosity grades. With the preferred high viscosity grades a range of concentration of about .3 to about .7% is indicated; with the lower viscosity grades up to about 1% is required for an equivalent effect.

Water soluble cellulose derivatives such as the water soluble salts of carboxy methyl cellulose are not suitable for purposes of this invention. Employing a standard laboratory testing procedure, a cement in which sodium carboxy methyl cellulose replace methyl cellulose displayed an increase of nearly tenfold in the incidence of edge-cracking.

Starch

The ternary binder provided by this invention includes 25-70% by weight of the binder of acid-hydrolyzed, pregelled starch.

A suitable starch may be prepared by suspending unmodified cornstarch (globe pearl) at 20% concentration in .1 N sulfuric acid and heating for six hours in a jacketed container held at 130-135° F., at the end of which time the crosses on the starch particles when viewed with a dark field microscope become indistinct but do not entirely disappear. At this point the sulfuric acid is neutralized with soda ash to pH 7 and the thus modified starch pregelatinized by cooking to 180-190° F. for a few minutes. The cooked starch is then flash dried in a thin film by exposure to 300° F. temperatures for a few seconds and recovered for use. Analysis of the starch so prepared shows 25.8% cold-water soluble and 7.6% moisture.

It should be appreciated that acid-hydrolyzed pregelled starches suitable for use in this invention are commercially available and need not be made in accordance with the above procedure. Unrefined corn flour is also a suitable raw material for a satisfactory starch product. The terms "starch" when hereinafter employed refers to a product similar to that above described.

The starch component of the ternary binder is relatively low in cost and favorably influences the obtaining of a good bond under low temperature and low humidity drying conditions. The use of starch in excess of the maximum percentage above set forth in Table I causes excessive drying shrinkage and check cracking.

Water dispersible polyvinyl acetate

Another component of the ternary binder provided by this invention comprises water dispersible polyvinyl acetate which should constitute between about 3 and 75% by weight of the binder. A number of these acetates are commercially available as free-flowing powders which may be redispersed in water to form a reconstituted polyvinyl acetate emulsion. These powders are usually prepared by spray-drying an emulsion polymer of vinyl acetate. The spray-dried polyvinyl acetates which have been found suitable for the purposes of this invention are stabilized with polyvinyl alcohol. It is preferred that the polyvinyl acetates of the binder provided contain approximately 5% by weight of polyvinyl alcohol.

The third component of the binder composition provided is cold-water soluble polyvinyl alcohol which should constitute between about 1.5 and 75% by weight of the binder. It should be noted that not all commercial polyvinyl alcohols are suitable for purposes of this invention. Commercial grades which are about 88% hydrolyzed are satisfactory; completely hydrolyzed polyvinyl alcohols are unsuitable, as are alcohols less than about 75% hydrolyzed.

The preferred polyvinyl alcohol contains about 12% polyvinyl acetate, and the preferred polyvinyl acetate contains approximately 5% polyvinyl alcohol. These percentages establish the minimum percentages above recited for each of these components; that is, if the binder contains the maximum 70% of starch, 30% of polyvinyl alcohol includes 3.6% (12% of the polyvinyl alcohol) of polyvinyl acetate in the binder. Similarly, 30% of polyvinyl acetate includes 1.5% (5% of the polyvinyl acetate) of polyvinyl alcohol.

Laboratory method of determining edge-cracking

In order to determine the edge-cracking which would result from the use of various joint cement compositions, the following testing method was devised.

The tests are conducted in a test room maintained at 5-10% relative humidity at approximately 85° F., with the test panel shielded from a direct blast from a heater fan. A test area approximately 3½ inches in width and 31 inches in length on a piece of gypsum wallboard is defined by two .017 inch thick spring steel screed strips. The test cement is mixed to the working consistency desired for the test (usually 100 plus or minus 10 Brabender units, measured with the heavy spring suspension, pin paddle, 72 r.p.m., in a ½ pint paint can). Exactly 80 grams of the wet mixed cement is applied as uniformly as possible to the test area with a broad knife and a 31-32 inch length of tape is immediately embedded into good contact with the cement. The simulated joint is allowed to dry in the test room, and the extent of crack development is observed with the aid of a five power hand lens. The total length of cracking relative to the 62 inch gauge length of tape edges is calculated to determine edge-cracking percentage. For best results the test is conducted in triplicate.

Under these test conditions a good quality commercial protein-based cement showed 76% edge-cracking. Cements illustrating the advantages of this invention were prepared in a fashion susceptible of representation on a conventional triaxial diagram and are disclosed in the diagrams of the drawings. Two levels of concentration of commercial methyl cellulose, .3% and .5%, were used.

Referring now to the drawing and more particularly to FIG. 1, a triaxial diagram of the ternary binder components is set forth therein in which the binder composition at each diagram corner represents 100% of the binder substance appearing thereat. Thus, at corner 1 the binder is 100% starch, the binder at corner 11 is 100% polyvinyl acetate (except for the polyvinyl alcohol content thereof), and the binder at corner 15 is 100% polyvinyl alcohol (except for the polyvinyl acetate content thereof). The composition of each of the fifteen numbers identifying an intersection of diagram axes indicates a specific cement composition employed and tested in accordance with the above-described method. Thus, point 5, for instance, depicts a cement containing 50% starch end member composition, 25% polyvinyl alcohol end member composition, and 25% polyvinyl acetate end member composition.

The following specific cement compositions employ binder compositions of the points 1, 11, and 15 of FIG. 1, as well as methyl cellulose as a thickener and conventional cement fillers;

TABLE II

	.5% Methyl Cellulose			.3% Methyl Cellulose		
	1	11	15	1	11	15
Dispersible polyvinyl acetate (containing 5% polyvinyl alcohol).....		8.0			8.0	
88% hydrolyzed polyvinyl alcohol.....			5.0			5.0
Starch.....	8.0			8.0		
Methyl Cellulose.....	.5	.5	.5	.3	.3	.3
Micaeous Fillers.....	45.2	45.2	45.2	45.2	45.2	45.2
Asbestos.....	6.5	6.5	6.5	6.5	6.5	6.5
Ground Limestone.....	39.8	39.8	42.8	40.0	40.0	43.0
Total.....	100	100	100	100	100	100

(All parts by weight.)

All of the cement compositions hereinafter discussed contain percentages of fillers substantially equal to those above set forth.

FIG. 2 illustrates the consistency of the fifteen compositions of FIG. 1 utilizing .5% methyl cellulose and a filler. It will be noted that the cement consistency, or cubic centimeters of water to form a paste of desired working consistency (which in the cements tested was 100 Brabender units plus or minus 10) with 100 grams of dry cement is affected by the starch content, polyvinyl acetate content, and polyvinyl alcohol content, in that order.

FIG. 3 reveals that similar consistencies result utilizing the binder compositions of FIG. 1 when .3% methyl cellulose is employed as a thickener in addition to conventional fillers. However, the consistencies of cements using the fifteen binder compositions of FIG. 1 are slightly less, on the average, when less of the methyl cellulose is employed.

The percentage of drying shrinkage for cements employing the fifteen binder compositions of FIG. 1 is illustrated in FIGS. 4 and 5. Methyl cellulose in the amounts of .5% and .3% by weight is used in the cements set forth in FIGS. 4 and 5 respectively. It will be noted that the percentage of shrinkage is affected by starch, polyvinyl acetate, and polyvinyl alcohol, in that order. Less shrinkage generally occurred with less thickener, as will be noted from a comparison of FIGS. 4 and 5.

FIG. 6 illustrates the preferred binder compositions of FIG. 1 to be employed for purposes of this invention by means of the shaded diagram area.

FIGS. 7 and 8 illustrate the improvement in check cracking suppression made possible by employing the binder compositions of FIG. 1; the cements of FIG. 7 employ .5% methyl cellulose, and those of FIG. 2 employ .3% methyl cellulose by weight as well as equal amounts of conventional fillers.

The numbers listed on the triaxial diagrams of FIGS. 7 and 8 are not percentage figures, but rather, relate to a scale in which 3 or lower is acceptable. It will be noted that a number of compositions displayed no check cracking whatsoever. From FIGS. 7 and 8 check cracking is seen to be affected primarily by the starch content, to a lesser degree by the polyvinyl acetate, and least of all by the polyvinyl alcohol in the compositions set forth.

FIGS. 9 and 10 depict the relative edge-cracking among cements utilizing the fifteen binder compositions of FIG. 1 together with .5 and .3% methyl cellulose, respectively, employed as a thickener, as well as equal amounts of conventional fillers. In FIGS. 9 and 10 the numerical values are percentage figures and graphically illustrate the tremendous improvement in edge-cracking suppression made possible by the joint cements provided. These low percentage figures are to be compared with the 76% figure given above for a good quality protein-based cement. The 76% figure was obtained following the very same testing procedure as has been previously mentioned.

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The illustrated cements are made at binder levels which will provide satisfactory bond to tape under reasonable conditions. For bonding under adverse conditions, such as low temperature and high humidity, the binder concentration may be increased. Conversely, cements which are intended for finishing or topping coats and which therefore need not exhibit such great adherence, may be formulated at lower binder levels. Accordingly the cement may be tailor-made to suit particular circumstances.

As will be observed from the illustrative formulations given, the binding efficiency of polyvinyl alcohol is superior to that exhibited by polyvinyl acetate or starch. In general, in the range in which polyvinyl alcohol and polyvinyl acetate are interchangeable, it has been found that only 70-80% as much polyvinyl alcohol as polyvinyl acetate is required for comparable binding efficiency. This advantage exhibited by polyvinyl alcohol is balanced from an economic standpoint by its higher cost compared to polyvinyl acetate.

In view of the flexibility of the novel cements provided, it is believed apparent that many modifications may be made in the illustrative examples given which will remain within the ambit of the inventive concepts disclosed.

This invention is to be limited only by the scope of the appended claims.

We claim:

1. A dry cement composition comprising from about .3 to 1% by weight of a cold-water soluble cellulosic thickener containing only ether and hydroxyl oxygen, about 4.5 to 12% by weight of a binder comprising a ternary mixture of acid-hydrolyzed pre-gelled starch, cold-water soluble polyvinyl alcohol which is not completely hydrolyzed but which is at least 75% hydrolyzed, and polyvinyl alcohol-stabilized polyvinyl acetate; and about 87 to 95% by weight fillers.

2. A dry cement composition for mixing with water to form a spreadable adhesive for securing joint tape to wallboard which comprises from about .3 to 1% by weight of a cold-water soluble cellulosic thickener containing only ether and hydroxyl oxygen, about 4.5 to 12% by weight of a binder comprising a ternary mixture of acid-hydrolyzed pre-gelled starch, cold-water soluble polyvinyl alcohol which is not completely hydrolyzed but which is at least 75% hydrolyzed, and polyvinyl acetate stabilized with about 5% polyvinyl alcohol; and about 87 to 95% by weight cement fillers.

3. The cement composition of claim 2 in which said ternary binder comprises about 25 to 70% by weight of the binder of acid-hydrolyzed pre-gelled starch, about 1.5 to 75% by weight of the binder of polyvinyl alcohol which is about 88% hydrolyzed and from about 3 to 70% by weight of the binder of water-dispersible, polyvinyl alcohol-stabilized polyvinyl acetate.

4. In a dry cement composition employing a cold-water soluble, cellulosic thickener containing only ether and hydroxyl oxygen and filler, the improvement comprising about 4.5 to 12% by weight of a binder of acid-hy-

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drolyzed pre-gelled starch, cold-water soluble polyvinyl alcohol which is not completely hydrolyzed but which is at least 75% hydrolyzed and polyvinyl alcohol-stabilized water-dispersible polyvinyl acetate added thereto.

5. The dry cement composition of claim 4 in which said starch is present in the amount of between about 25 and 70% of said binder by weight, said polyvinyl alcohol is present in the amount of between about 1.5 and 75% by weight of said binder and said polyvinyl alcohol-stabilized polyvinyl acetate is present in the amount of between about 3 and 75% by weight of said binder.

6. The dry cement composition of claim 4 in which said polyvinyl alcohol is approximately 88% hydrolyzed.

7. The dry cement composition of claim 4 in which said polyvinyl alcohol contains about 12% polyvinyl acetate by weight and said polyvinyl acetate contains at least 5% polyvinyl alcohol by weight.

8. The dry cement composition of claim 4 in which said cold-water soluble cellulosic thickener is present in the amount of about .3 to 1% by weight.

9. A dry cement composition capable on mixing with water to form a spreadable cement suitable for adhering paper tape to wallboard joints which comprises in combination with fillers from about .3 to about 1% by weight of a water soluble cellulose-based thickener which contains only ether and hydroxyl oxygen and from about 4.5 to about 12% by weight of a ternary binder made up of from about 25 to about 70% by weight of the binder of acid-hydrolyzed pre-gelled starch, from about 1.5 to about 75% by weight of the binder of cold-water soluble polyvinyl alcohol which is not completely hydrolyzed but at least 75% hydrolyzed, and from about 3 to about 70% by weight of the binder of water-dispersible, polyvinyl alcohol-stabilized polyvinyl acetate.

10. A dry cement composition adapted on mixing with water to form a spreadable cement for securing joint tape to wallboard which comprises by weight between about 5-10% asbestos, 10-60% micaceous fillers, .3-1% cold-water soluble cellulose derivative containing only ether and hydroxyl oxygen, 4½-12% binder, and sufficient limestone filler to total 100%, the binder portion thereof being a ternary mixture of acid-hydrolyzed pre-gelled starch in the amount of about 25 to about 70% by weight of said binder, cold-water soluble polyvinyl alcohol which is not completely hydrolyzed but at least 75% hydrolyzed in an amount of about 1½ to about 75% by weight of said binder and water-dispersible, polyvinyl alcohol-stabilized polyvinyl acetate in the amount of about 3 to about 75% by weight of said binder.

11. The composition of claim 10 in which the total of polyvinyl alcohol and polyvinyl acetate in the ternary binder system exceeds about 30%.

References Cited in the file of this patent

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UNITED STATES PATENT OFFICE
CERTIFICATION OF CORRECTION

Patent No. 3,003,979

October 10, 1961

Mitchell P. Ptasienski et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 37, for "celluolse" read -- cellulose --;
column 6, line 52, for "FIG. 2" read -- FIG. 8 --.

Signed and sealed this 3rd day of April 1962.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

DAVID L. LADD

Commissioner of Patents