Patented Apr. 18, 1944 2,346,999

UNITED STATES PATENT OFFICE

2,346,999

MANUFACTURE OF COMPOSITE WALLBOARD

John Briscoe Sandford, Saltburn, and Victor Lefebure, London, England, assignors to Imperial Chemical Industries Limited, a corporation of Great Britain

No Drawing. Application October 15, 1941, Serial No. 415,148. In Great Britain June 30, 1937

32 Claims. (Cl. 154—2)

This invention relates to the manufacture of composite wall board consisting of a layer of water-setting cementitious material such as calcium sulphate plaster covered on one or both sides with relatively thin fibre liner, e. g. pulp board, thick paper, cardboard or the like, which is caused to adhere firmly to the cementitious material by allowing the latter to set in contact therewith, if necessary under pressure.

In plasterboard of this type the cementitious material is most generally plaster of Paris, hereinafter called stucco, but catalysed anhydrite plaster, and mixtures of stucco and catalysed anhydrite can also be used. As is well known the board is usually made by a continuous sheeting method. The dry plaster, with certain modifying agents to be described later, is mixed with water to give a semi-liquid plastic mix and this is delivered on to the lower of two moving webs of liner which are fed respectively over two spaced vertically superimposed rolls, known as master rolls, which mould the board. The bottom liner is arranged to be wider than the top one and is scored and folded over by means of side edge formers which are placed in front of the master rolls and extend into the nip. Boards having edges totally enclosed in liner are produced in this way. The wet formed board travels down a long conveyor placed beyond the rolls and of such a length that the core has set and become sufficient hard to permit the board to be cut by the time it reaches the knife situated at the end of the conveyor. The knife generally consists of a double rotary cutter with two blades having saw-toothed edges. The blades are superimposed, move in the same direction at the moment of cutting, and operate by severing the liner and cutting into the set core. An accelerating device forces the board forward and facilitates clean cutting. The knife can be set by suitable means to cut boards of different thicknesses and lengths. It will be clear that the distance between the master rolls and the knife, or in other words the length of the conveyor, will be determined by the setting properties of the mix and by the speed of plant running. The cut boards are then transferred to a kiln or drier generally of the continuous roller conveyor type in which the inlet temperature may be 130°–300° C., and is preferably 130°–150° C., and in which the outlet temperature may be 70–130° C., and is preferably 100–125° C., and are there dried. With plasters of the anhydrite type, which hydrate more slowly, a maturing interval of from 18–30 hours is necessary between cutting and transfer to the kiln, and lower drying temperatures are generally necessary owing to the smaller amount of water to be evaporated.

The following is a brief explanation of what happens during the process of manufacture. The wet mixed plaster as it is applied to the paper has not hydrated and does not indeed hydrate appreciably until some time after the board has passed the master rolls. If any degree of hydration were allowed to take place prior to the rolls pre-setting of the core would occur and this would cause poor core adhesion and weakness in the core. Retarder is added to the mix to prevent the occurrence of such conditions. As the board passes down the conveyor the plaster gradually sets and some of the supersaturated gypsum solution from the core mix passes into the paper. The plaster sets before the knife is reached, and just before the completion of set the gypsum in the solution which has penetrated into the liners is precipitated, and the crystals so formed provide the bond between the core and the paper. In the manufacture of good board this initial bond, as it is called, between paper and core should develop well before the knife to prevent detachment of the liners from the core during the cutting operation. The core is completely hydrated before the boards enter the kiln and the drying process simply consists in evaporating off the free moisture. Sharp rapid drying without dehydration produces the best boards.

The wet plastic mix invariably contains additional ingredients which are added to confer special properties. Thus wood fibre and other cellulosic materials are added to reduce density, to confer improved strength, and to improve the nailing and sawing qualities of the boards; foam produced by the aeration of aqueous solutions of organic colloidal matter is frequently added to the wet plastic mix to reduce density, or is formed in situ by incorporating in the mix chemicals which interact to give gas bubbles; retarders of plaster set, such as scutch prepared for example from keratinous refuse, are added with the object of facilitating the passage of the core mix through the mixers without setting; accelerators, such as ground set gypsum blocks or masses derived from plaster of Paris for example the ground cores of old plaster boards, are added with the object of causing the core mix to set sufficiently hard to be capable of being cut within the time interval permitted by plant design; and materials known as core adhesives are

added to promote bond between the setting core and the paper.

This quality of bond between core and liner is of the utmost importance in the manufacture of good plasterboard because upon it depends the strength and integrity and performance in use of the board. Indeed it is true to say that without it commercially sound plasterboard does not exist. Poor bonding yields a weak board in which the full strength of the reinforcing liners is not utilised and one which will disintegrate when subjected to the effect of damp or when a coat of plaster is applied to it. Even if the core bond is patchy it frequently happens that when a plaster face coat is applied, the water from it soaks into the liner, which then commences to bulge over the patches. Later, as the plaster dries, the paper is pulled away from the core where the adhesion is poor and cracking and detachment of the plaster take place. It will thus be seen that good bond between core and liner is a sine qua non in plasterboard of commercial standards and quality.

The mechanism of the formation of bond between core and liners has already been described. It is well known, however, in the art of plasterboard manufacture that the bond so produced by any type of plaster whether stucco, or anhydrite, or indeed any other type is not sufficiently good to give a commercially sound plasterboard and it is invariably necessary to incorporate in the core mix an adhesive, known as a core adhesive, to promote the necessary good bond. It is not known why such adhesives are necessary but it is nevertheless a fact that they are necessary. Suitable adhesives are starches, chemically treated and so-called soluble starches, dextrines, gums, urea formaldehyde and thiourea formaldehyde resin syrups, and other water soluble or dispersible substances. The amount of the core adhesive necessary varies greatly and is determined partly by its own properties and partly by the characteristics of the plaster: generally, however the extreme proportions vary between 0.25% and 3% by weight of the dry plaster. (In the following description the proportions of all ingredients in any mix or composition are expressed as a percentage by weight of the dry plaster used in the said mix or composition.) Thus from 0.3–1.5% starches, gums and dextrine and 1.0–2.0% urea formaldehyde syrup containing 75% resin substance or equivalent amount of different syrups, may be used for stuccos manufactured from rock gypsum and 0.75%–3% of the former adhesives and 1.5–2.0% of the latter may be used for stucco prepared from by-product gypsum, and for other types of plaster. In commercial practice it is never possible, even with the best plasters, to employ less than 0.25% of core adhesive if adequate bond is consistently to be obtained in continuous operation, and in order to provide a safety factor at least about 0.5% is generally employed. All these adhesives are many times as expensive as the plaster and the cheapest will cost twenty times as much as the plaster per unit weight. It would therefore be extremely desirable to eliminate them from the core mix and very many attempts have been made to do so but none of these so far as we are aware has been successful.

It is an object of this invention to make commercially sound plasterboard from ordinary plasters without the necessity of having to add adhesive to the core mix, and particularly to do this on continuous plasterboard machines. It is also an object to provide an improved method of securing good adhesion between the cementitious material and the liner or other fibrous surface, especially where the cementitious material has poor bonding powers or where the liners do not possess suitable properties for bonding. A further object is to provide a method of securing a much improved adhesion between the cementitious material and the liners or other fibrous surface. A further object is to provide an adhesive composition specially adapted to secure a good bond between the cementitious material and the liners or other fibrous surface. A further object is to provide this improved bond by a method which is suitable for use in connection with fast continuous plasterboard machines and in which the initial wet bond between plaster and liner develops sufficiently quickly to enable the machine to be run at the highest speeds. A still further object is to provide stronger and improved plaster boards. A still further object is to provide a method whereby stronger plaster boards with enhanced resistance to water can be obtained. A still further object is to provide plaster boards with enhanced resistance to water. Further objects will appear hereinafter.

We have found that these objects can be attained by the method hereinafter described according to which a positive bond is provided between the core and the liner. This method consists in applying to the liners before they come into contact with the wet core mix a coating consisting of a water setting plaster or cement, in admixture with water and with a water-soluble or water-dispersible adhesive. It would appear that the water setting cement and water soluble adhesive in the coating bond to the paper and that the water setting cement of the core bonds to the water setting cement in the coating, since a coating of water setting cement alone or of water soluble adhesive alone does not give the same effect. In the production of plasterboard from plaster core mixes on fast continuous machines the water setting cement will generally be plaster of Paris, i. e. stucco. The proportion of water soluble or dispersible adhesive should not be less than 5% by weight of the stucco in the coating. The amount of water varies betwen 45% and 600% by weight of the stucco and is determined by the properties of the water setting cement of which the core is composed, the properties of the paper, and the method of applying the coating to the liners. The coating may be applied by means of doctors, applicator rolls, brushes, troughs, spray or the like. The coating may be used in either of two ways, viz. the wet way which consists in applying it to the liners on the plasterboard machine a short distance in front of the rolls and allowing it to become tacky before it comes in contact with the plastic core mix, or the dry way, according to which it is applied to the liner in a prior operation and dried and the dry coated liner is reeled for subsequent use on the plasterboard machine. For various reasons, which will be given later, the first method is preferred.

In using the wet way it is important that the coating should be in the correct tacky condition before it is brought into contact with the core mix. Several factors contribute towards this condition, among which the speed of running, the water absorptive properties of the liner and the atmospheric temperature appear to be the more important. The tackiness appears to be brought

about by the absorption of water from the coating by the liner and by surface evaporation into the air, and so far as we are aware, practically no hydration has occurred in the coating at this stage. Indeed marked hydration in the coating at the tacky stages results in poor final bond. If the tacky condition is not sufficiently attained before the core mix is applied, the coating will be too liquid and will tend to be rubbed off by the friction of the latter, particularly in the neighbourhood of the master rolls: on the other hand, if the coating has gone beyond the tacky stage when the core mix is applied it will be too dry and the final bond will be poor. The correct conditions are achieved by adjusting the position of the application means and by varying the proportion of water in the coating mix. The weight of the coating applied will depend partly upon its composition, partly upon that of the core mix, and partly upon the nature of the paper, but it will not in general exceed 0.4 lb. per sq. yard of liner and will preferably amount to about 0.2 lb. per square yard. It will thus be apparent that fairly wide latitude must be allowed in selecting all these factors to give the best results.

We have found that the invention may be successfully carried out on continuous machines by employing the following range of variations in the composition and weight of the coating.

Stucco	parts by weight	100
Adhesive	do	5–50
Water	do	45–600
Weight of coating lb. per sq. yd. of liner (depending upon the water proportion)		0.15–0.6

The preferred ranges are

Plaster	parts by weight	100
Adhesive	do	5–20
Water	do	55–100
Weight of coating lb. per sq. yd. of liner		0.2

It is generally unnecessary to employ more than 20 parts of adhesive because no further benefit is obtained. However with catalysed urea formaldehyde or thiourea formaldehyde syrups up to 50% (based on the weight of plaster) of syrups containing 75% resin substance may be used to give a bond having improved water resistance resulting from the resinification of the syrups during the drying operation. Beyond this proportion the bond is not so good and its development initially is slow.

Of the adhesives gum arabic, karaya gum, and dextrine are preferred for ordinary plasterboard, and urea formaldehyde syrup for boards to be used in outside situations where more water resistant bond is necessary.

Where necessary these coating mixes may be retarded or accelerated in the same way as ordinary plasterboard core mixes. Organic scutch is the preferred retarder and ground set gypsum plaster is the preferred accelerator. The main objects of retarding are to prolong the life of batches of liquid coating which would hydrate too quickly to be capable of storing, to prevent fouling of the application equipment, and to prevent the formation of gypsum in the liquid mix prior to the tacky stage. The object of accelerating the hydration is to prevent too long delay in the attainment of initial adhesion with coating mixes containing a large proportion of an adhesive, such as gum arabic, which is itself a retarder.

The invention may be used in any method of making plasterboards, but as already mentioned the primary object is to produce on rapid continuous machines plasterboard possessing adequate core adhesion from plaster mixes containing no core adhesive. It is, however, a requirement of production on rapid continuous plasterboard machines that by the time the board has reached the knife the core should be sufficiently hard, and the bond between core and liner should be sufficiently strong, to enable the board to be cut. If the second condition is not fulfilled, the knife as it penetrates into and is again withdrawn from the board during the cutting operation will detach the liners from the core at the ends. The liners so detached do not bond again to the core in the subsequent process and consequently the boards have weak ends which are liable to be easily damaged by knocking or by water ingress. It is a secondary advantage of our invention that initial adhesion develops rapidly. This is due to the presence in the coating of the setting cement, viz. plaster of Paris, because initial adhesion only develops slowly if the attempt is made to coat the liner with solutions of gum, dextrine, and urea formaldehyde syrup or starch paste, containing no added water setting cement. (It should be mentioned that the final dry bond produced in these last ways is inferior.) This is of particular advantage where the water setting cement or plaster employed in the core mix develops initial bond slowly. This advantage of early initial adhesion is best achieved by using coatings containing plaster of Paris. The development of initial bond can be hastened by introducing an accelerator such as ground set gypsum in the coating.

It is important that the liquid coating should not contain gypsum (other than accelerator) or at any rate very little gypsum, otherwise the final bond is not good. This can be achieved by arranging that it is used before any noticeable stiffening occurs or better by determining the time for an increase in hydration of 1.0% and ensuring that the mix is used before this is attained. Where the mix is made and used continuously this difficulty does not occur.

In carrying out the invention by the dry way referred to herein, the composition of the mix will generally be as before, but as the coated liner is rolled and there is therefore some danger of the dry coating cracking and flaking off it is desirable to use the minimum weight of coating and also to use more water in the mix. Very good results are obtained by using 0.2 lb. per sq. yard of a coating having the composition:

	Parts by weight
Stucco	100
Adhesive	5–20
Water	100–600

The method of use is to apply the coating to the liner by means of a doctor, roller, brush, trough, or other known means of application and to dry rapidly by passing it over a hot cylinder at 140°–180° C. with the coating towards the hot surface or to direct a current of air at a temperature of 140°–180° C. onto the coating. The time of application of the heating medium should be about 20–40 seconds. Apparently very little gypsum is formed and consequently good core bond is obtained when the dry coated liner is brought into contact with the wet plaster core mix. If the coating is allowed to dry slowly in air hydration of the plaster of Paris occurs and

poor core bond is obtained in the plasterboard process. As we have said it is desirable that the amount of gypsum, other than accelerator, present in the coating at the time of application of the core mix should be kept low and should correspond to an increase in hydration of not more than 1.0%. Liner coated in this way may be stored for many months and at the end of that time can be used to make plasterboard possessing adequate core adhesion. The disadvantages of employing the dry way are that the extra drying and handling operations add to the expense and reduce the economic advantages of the process, and that it is difficult unless expensive reeling equipment is provided to reel the dry coated liner so that the reels have the square edges that are essential to plasterboard manufacture. If the edges are not square the liners weave in the plasterboard machine and in consequence efficiency of production falls and a large number of low quality boards having poor edges is produced. It will thus be seen that the dry way has a more limited sphere of usefulness than the wet way.

It will be understood that the present invention has valuable application to any core mix which is, of itself, incapable of giving good bond to plasterboard liners, and in particular to any core mix which is incapable of being used on a continuous plasterboard machine to yield a commercially acceptable product. It will also be understood that in the preferred form of the invention the core mix is one free from adhesive or is one containing a proportion of adhesive relatively small compared with that hitherto employed in commercial practice, since it is thereby possible to achieve the maximum economy as a result of the discovery on which the present invention is based, namely, the discovery that it is possible to provide a positive bonding interlayer between the core and the liner instead of relying upon modification of the core mix as has hitherto been believed to be necessary.

The present invention therefore does not exclude the uses of core mixes modified for purposes other than that of giving good bond to the plasterboard liners. Thus it is common practice in the art of plasterboard manufacture to add prepared foams to the core mix to reduce the density of the boards and to improve the insulating properties. Liners coated by the wet and dry methods of our invention can be used on the plasterboard machines with core mixes containing foam to give the aforesaid advantages of good bond and early development of initial bond, and this without the addition of special core adhesives. Frequently the added foam contains gum, dextrine, starch, glue or casein as stabiliser. The amount of this stabiliser is generally about 0.3% of the weight of stucco and it does not give adequate core adhesion in the made plasterboard. Our invention covers the use of the positive bond coating of the invention with such foamed core mixes in which the total adhesive substance in the mix, exclusive of glue or casein, does not exceed 0.3% by weight of the stucco. As foamed core mixes do not bond so well to liner as ordinary mixes the application of our invention to them is of great advantage. Foams having glue as stabiliser, although possessing excellent stability, could be used in core mixes heretofore because the presence of the glue prevents bonding to the paper even although excessive proportions of the ordinary core adhesives are used. We have found that mixes containing foams of this type can be made to bond to liner by using our new positive bond coating. It is therefore to be understood that the invention covers the use of these coatings in combination with foamed plaster core mixes which do not of themselves bond to the liners.

The strength of the core bond is assessed in the following way. A sample of the board to be tested, about 6" square, is taken and the attempt is made to strip the liner from the core. If after repeated attempts it is found impossible to expose the core and the liner continues to tear in itself, the bond is regarded as excellent, and an arbitrary adhesion value of 10 is assigned. If after repeated attempts it is found impossible to expose an area of core exceeding $\frac{1}{32}$" in depth, an adhesion value of 8 is allocated. If after similar treatment the core can be exposed over an area of $\frac{1}{32}$"–$\frac{1}{16}$" in depth, an adhesion value of 7 is allocated. If after similar treatment the core can be exposed over an area $\frac{1}{16}$"–$\frac{1}{4}$" in depth an adhesion value of 6 is allocated. If the liner can be completely stripped from the core and leaves no fibre attached to the latter an adhesion value 0 is allocated. Intermediate values are allocated to all degrees of bond between 10 and 0. In commercially sound plasterboard the bond or adhesion value as determined in this way should preferably be 8 or more, and must in no circumstances be less than 7.

The advantages of the invention are illustrated by the following series of tests, and the method of execution by Examples 1–10.

Plasterboards made from wallboard liner and core mixes having the following compositions were dried in the usual way and gave the adhesion values indicated.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Stucco (made from rock gypsum)	100	100	100	100	----	----	----	----
Stucco (made from by-product gypsum)	----	----	----	----	100	100	100	100
Sawdust	4	4	4	4	4	4	4	4
Dextrine (99% soluble in cold water)	----	0.25	0.4	0.5	----	0.25	0.4	0.5
Organic scutch retarder	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Water	65	65	65	65	62	62	62	62
Adhesion values	0	6	8	8	0	5	7	8

These results indicate that with the stucco made from rock gypsum adequate bond could not be obtained with less than 0.3% dextrine, and that with stucco made from by-product gypsum adequate bond could not be obtained with less than 0.4% dextrine. Similar results are obtained with other adhesives.

Further boards were made from the same liner using the core mixes (1), (2), (5) and (6) respectively and applying coatings having the following composition by the wet method. The coatings were applied by brush and the core mix was brought into contact with the liners 20 seconds after aplication. The weight of coating applied was 0.2 lb. per sq. yard of liner.

	Parts by weight
Stucco	100
Dextrine	5
Retarder	0.14
Water	100

Each of the dried boards showed an adhesion value of 9.

These results demonstrate the improved core bond obtained by using the method of our invention.

A further lot of boards was prepared from

core mixes (1), (2), (5) and (6) using the same liners and applying by the wet method 0.20 lb. per square yard of a coating having the following composition.

	Parts by weight
Stucco	100
Dextrine	2.5
Retarder	0.14
Water	100

The dried boards made from mixes 1 and 5 had an adhesion value of 5, while those from mixes 2 and 6 had an adhesion value of 6.

The same results have been obtained with other adhesives. To ensure consistent adequate commercial bond we consider it necessary to use not less than 5% water soluble adhesive based on the weight of stucco.

Example 1

The coating composition consisted of 100 parts of plaster of Paris 25 parts of urea formaldehyde resin syrup, and 45 parts of water. This was applied to the inner face of the two liners which contacted with the mixed setting plaster of Paris core containing no modifier, within three minutes of application. About three ounces of coating composition were employed per square yard of liner. Perfect initial adhesion was developed in thirteen minutes, and the life of the coating mix was at least fifteen minutes.

The adhesion after 45 hours' exposure of the finished board to water was also perfect, which result would not have been obtained otherwise.

Example 2

100 parts of plaster of Paris were mixed with 7.6 parts of water soluble gum, 12.5 parts of urea formaldehyde resin syrup and 57 parts of water. A foam plasterboard core containing no added core adhesive was employed contacting with the coated liners within three minutes of application of the coating. Perfect adhesion was obtained in the final board, far better than any adhesion previously obtained with foamed cores without the use of the positive bond coating.

Example 3

Parallel tests were made with the mixes of Examples 1 and 2, with board liners of very low absorption and very smooth surface which did not give any adhesion when normal plaster of Paris board cores were employed. These liners, however, gave perfect adhesion with such normal plaster of Paris cores when the liners were treated with the mixes and in the manner indicated in Examples 1 and 2.

Example 4

100 gms. of the kind of plaster of Paris known as coarse boiled plaster was mixed with 25 to 10 ccs. of catalysed urea formaldehyde resin syrup (containing 45 per cent of solids) in admixture with 45–55 ccs. of water. The resulting coating composition was applied to the liners as in Example 1 with similar excellent results.

Example 5

100 gms. of the kind of plaster of Paris known as coarse boiled plaster was mixed with 70–15 ccs. of 20 per cent gum arabic solution, together with up to 50 ccs. of water if necessary to strain a suitable consistency. This again gave a perfect bond.

Example 6

Plasterboard was made from a core mix having the following composition.

	Parts by weight
By-product plaster of Paris	100
Sawdust	4
Organic retarder	0.10
Water	62

The water was heated to 40° C. to promote rapid hardening.

The plaster of Paris used in this example was obtained as a by-product in the manufacture of phosphoric acid from phosphatic rock and is referred to in subsequent examples as phosphate stucco.

A liquid coating having the formula:

	Parts by weight
By-product plaster of Paris	100
Gum arabic	5
Organic retarder	0.045
Water	60

was applied by means of two V shaped troughs bearing upon the paper and set so that the clearance between the bottom face of the trough and the paper surface was $\frac{5}{1000}$ of an inch. These troughs were each placed about 6 feet in front of the master rolls. The weight of coating applied was approximately 0.25 lb. per square yard of liner. The board was fabricated in the usual way. Initial adhesion developed at 14 minutes. The boards were cut and transferred to the kiln where they were dried for 1½ hours using an inlet temperature of 200° C., an outlet temperature of 75° C., and an air velocity of 10 feet per second. The dried boards had a core adhesion value of 9.

Example 7

¼" thick boards were made from a core mix consisting of a mixture of plaster of Paris and anhydrite with added catalysts, and a liner of the type known as baseboard, which contains about 30% of jute fibre. The core mix had the following composition:

	Parts by weight
Ground anhydrite	70
Plaster of Paris from rock gypsum	30
Potassium sulphate	1.0
Zinc sulphate	1.0
Water	32

and was retarded with 0.03% of a mixture of sodium hexa- and meta-phosphates known under the name Calgon.

To the liners about 6 feet front of the master rolls was applied a positive bond coating having the formula:

	Parts by weight
Phosphate stucco	100
Dextrine	5
Water	80
Calgon	to give an inital set by Vicat of 20 minutes

Initial adhesion developed at 5½ minutes and it was possible to cut at 7 minutes after mixing, thus enabling a plant speed of 15 feet per minute to be obtained. It had not been possible previously to make board from this core mix owing to the very long delay—several hours—in the development of initial adhesion. The improvement was due to the quick initial bonding of the coating to the liner, followed by the bonding of the core mix to the coating. The boards were allowed to mature in air for 24 hours and

were then dried for 1¼ hours with an inlet temperature of 150° C. and an outlet temperature of 70° C. The final core adhesion value was 9.

Example 8

Boards were made from a core having the composition:

	Parts by weight
Ground anhydrite	70
Plaster of Paris from rock gypsum	30
Potassium sulphate	1.0
Zinc sulphate	1.0
Water	32
Calgon	0.04

A liquid coating having the formula:

	Parts by weight
Phosphate stucco	100
Urea formaldehyde syrup (75% solids)	50
Water	145
H_2SO_4 (catalyst)	0.05

was applied by brush to strawboard liners at the rate of 0.2 lb. per square yard of liner. 20 seconds after application the liners were brought to contact with the core mix. Initial adhesion developed at 4 minutes. The board was allowed to mature in air for 24 hours and was then dried. The final core adhesion was 10.

Example 9

Boards were made from a core having the composition:

	Parts by weight
Phosphate stucco	100
Sawdust	4
Calgon	0.03
Water	60

To the liners, which were of strawboard, 20 seconds before the application of the core mix there was applied by means of a brush 0.2 lb. per square yard of liner a positive bond coating having the following composition:

	Parts by weight
Stucco	100
Dextrine	5
Scutch retarder	0.03
Water	100

Initial adhesion developed at 6 minutes and after drying the core adhesion value was 10.

Example 10

0.030" strawboard liners were coated by means of a brush with a positive bond coating having the composition:

	Parts by weight
Phosphate stucco	100
Dextrine	15
Water	100

0.2 lb. liquid coating was applied per square yard of liner. They were dried at 160° C. for 40 seconds and were then laid aside.

Boards were made from these dry pre-coated liners using a core mix as follows:

	Parts by weight
Ground anhydrite	70
Plaster of Paris from rock gypsum	30
Potassium sulphate	1.0
Zinc sulphate	1.0
Water	32
Calgon	0.04

A thin coating of water was applied to the liners 15 seconds before applying the plaster mix. Initial adhesion developed in 5 minutes. The boards were allowed to mature in air for 24 hours and were then dried. The final adhesion was 10–9.

In Examples 1, 2, 4 and 5, retarded hemihydrate plasters could be used to modify the behaviour of the wet coating, with a view to prolonging the life of the wet mix in the mixing vessel and in the coating appliance. Accelerators and retarders could also be added as required. A larger proportion of urea resin syrup could also be used, e. g. 25–50 ccs. per 100 gms. of plaster. This would delay the development of adhesion, but would be feasible in a plant operating at a low speed or with a very long conveyor.

Instead of the gum arabic used in Example 5, other gums, such as karaya gum, water-soluble derivatives of cellulose, gum tragacanth, starch, or mixtures thereof, could be used. If dextrine is used as water-soluble adhesive, it should contain the minimum of insoluble material.

By varying the proportions of the constituents the setting time of the coating compositions can be adjusted to suit the requirements of the coating and board-making operations. Fibre liners treated with these compositions adhere firmly to the water-setting cementitious material forming the body of the composite board. If the plaster is omitted from the composition, or is replaced by an inert filler, adhesion to the cementitious materials falls far short of that required for commercial purposes.

Good results have been obtained with aqueous urea-formaldehyde or thio-urea-formaldehyde resin syrups such as are obtained by reacting urea or thio-urea with formaldehyde in aqueous medium and removing a portion of the water or not as required. A typical resin syrup may contain 50%–75% of resin substance, the balance being water. It will be understood that the resin is in the reversible or uncured state and that the resin may be applied in any solid form capable of being dissolved or dispersed in water to give a solution, colloidal dispersion or emulsion. Resin accelerators may be employed in the mix. The plaster may be mixed with the syrup or solid form of resin and water if necessary to a consistency suitable for the chosen method of application, e. g. a thin paint for brushing or spraying, or a thicker paint for application by rolling, or by means of a spreading knife.

The plaster used in preparing the coating composition may be any known kind of calcium sulphate plaster other than dead burnt plasters, for example, stucco, plaster of Paris, coarse boiled plaster, anhydrite plaster and the like. However, in order to obtain the early development of initial adhesion necessary on a fast continuous machine, plaster of Paris or its modifications is preferred. The plaster forming the core may be any of the above mentioned plasters, or a dead burnt plaster, e. g. Keene's cement, or any other known kind of calcium sulphate plaster.

This invention is a valuable advance in the art as the bond between the liners and the core of the plaster board is one of the most important properties of a good plasterboard as well as one of the largest factors in providing the strength of the final plaster board. The invention provides a method whereby this bond can be both improved and made more lasting.

An important advantage introduced by the coatings which contain the urea or thio-urea synthetic resins is in regard to waterproofing effect. Thus for example a typical normal plasterboard with edges treated to prevent the entry

of water so that water could only enter through the liner faces was immersed in water the board absorbed about 50 per cent. of its weight of water, with considerable weakening of the core and thus of the board itself. A board was made identical in all respects with the above except that the liner was treated with the resin composition coating in accordance with this invention. In the same period of time this board had only absorbed 6 per cent of its own weight of water.

Further, this new method of producing plasterboard whereby the liners are coated with the resins instead of modification of the core with resins is more rapid, more foolproof, and cheaper.

The economic advantages are well illustrated by the following example:

It was found that 0.75% dextrine or gum arabic was necessary as core adhesive to give a core adhesion value of 8–9 with a certain stucco. On eliminating the core adhesive and applying a positive bond coating by the wet method it was found possible to obtain a core adhesion value of 9. The positive bond coating was as follows, 0.2 lb. of the liquid composition being applied per square yard.

	Parts by weight
Stucco	100
Dextrine	5
Retarder	0.10
Water	100

The amounts of adhesive used per 1000 square feet of board in the two cases were:

	Amount of dextrine lb./1000 sq. ft.
Board with adhesive in core	10
Board with adhesive in positive bond coating only	1.1

As the adhesive costs about 6 cents per lb. the benefits are obvious. With favourable conditions even greater economies are achieved than this.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specified embodiments thereof, except as defined in the appended claims.

In the claims, the term water-diffusible to define the adhesive material is used as including both water-soluble and water-dispersible adhesives.

We claim:

1. A method of manufacturing composite plasterboard which comprises applying to a liner a coating comprising an aqueous mixture of a water-setting cementitious material with a water-diffusible adhesive, and applying said coated liner to an unset plastic core mix containing a water-setting cementitious material, said core mix being incapable, in the absence of the said coating, of bonding to the liner.

2. A method as claimed in claim 1, in which the core mix is one free from adhesive.

3. A method as claimed in claim 1, in which the core mix contains less than 0.5 per cent. of adhesive.

4. A method as claimed in claim 1, in which the water-setting cementitious material in the core mix is a calcium sulphate plaster.

5. A method of manufacturing composite plasterboard, which comprises applying to a continuously advancing liner sheet an aqueous mixture of a water-setting cementitious material and a water-diffusible adhesive, drying the coating so formed to the tacky stage, applying the said coated liner while it is still advancing to an unset plastic core mix containing a water-setting cementitious material, said core mix being incapable, in the absence of the said coating, of bonding to the liner, allowing the core mix to set, cutting the advancing set board into lengths and drying the cut lengths.

6. A method as claimed in claim 5, in which the coating comprises a mixture of plaster of Paris together with between 5 per cent. and 20 per cent. by weight of adhesive calculated on the weight of the plaster.

7. A method as claimed in claim 5, which comprises applying to the liner a coating composition comprising a mixture of a calcium sulphate plaster with a water-diffusible adhesive together with an amount of water between 45 per cent. and 600 per cent. by weight of the plaster.

8. A method as claimed in claim 5, in which the weight of coating applied to the liner is 0.2 lb. per square yard.

9. A method as claimed in claim 1, which comprises treating a continuously advancing liner sheet with an aqueous mixture of a water-setting cementitious material and a water-diffusible adhesive, rapidly drying the coating so formed, thereafter applying the unset plastic core mix to the treated liner while it is still advancing, allowing the core mix to set, cutting the advancing set board into lengths, and drying the cut lengths.

10. A plasterboard comprising a set core of a water-setting cementitious material of the kind incapable by itself of bonding to a plasterboard liner, and a liner bonded to said core by means of a coating comprising a water-setting cementitious material and a water-diffusible adhesive.

11. A plasterboard as claimed in claim 10, in which the core is free from adhesive.

12. A plasterboard as claimed in claim 10, in which the core mix contains less than 0.5 per cent. of adhesive.

13. A plasterboard as claimed in claim 10, and comprising a foamed core mix containing not more than 0.3 per cent. of adhesive calculated on the weight of the cementitious material.

14. A plasterboard as claimed in claim 10, in which the water-setting cementitious material in the core mix is a calcium sulphate plaster.

15. A plasterboard comprising a core of a set composition containing plaster of Paris and of the kind incapable by itself of bonding to a plasterboard liner, and a liner bonded to said core by means of a coating comprising a mixture of set plaster of Paris together with between 5 and 50 per cent, calculated on the weight of the plaster, of a resin syrup selected from the class consisting of urea formaldehyde resin syrup and thiourea formaldehyde resin syrup.

16. A plasterboard as claimed in claim 10, in which the coating comprises a mixture of plaster of Paris together with between 5 per cent. and 20 per cent. by weight of adhesive calculated on the weight of the plaster.

17. A plasterboard as claimed in claim 10, in which the adhesive is selected from the class of acid-catalysed urea formaldehyde resin syrups and thiourea formaldehyde resin syrups.

18. A plasterboard as claimed in claim 10, in which the adhesive is selected from the class consisting of gun arabic, karaya gum and dextrine.

19. A continuous method of manufacturing composite board having a core and a liner which comprises pre-coating a web of fibrous liner with

an adhesive composition comprising a water-settable cementitious material intimately commingled with a water-soluble adhesive to form a binder coating, continuously forming a plasterboard by continuously applying a core layer of water-settable unset cementitious material to the treated side of a continuously advancing web of said liner; before the binder has set traveling the composite web and core until the initial set has occurred, then cutting the composite web into sheets, allowing the core and binder to set completely, and thereafter heating the sheets to dry them.

20. A continuous method of manufacturing composite board having a core and a liner which comprises precoating a web of fibrous liner with an adhesive composition comprising a mixture of plaster of Paris intimately commingled with between 5 and 50 per cent, calculated on the weight of the plaster of Paris, of a water-soluble adhesive selected from the class consisting of urea formaldehyde resin syrups and thiourea formaldehyde resin syrups, continuously forming a plasterboard by continuously applying a core layer of plaster of Paris to the treated side of a continuously advancing web of said liner; before the adhesive composition has set traveling the composite web and core until the initial set has occurred, then cutting the composite web into sheets, allowing the core and binder to set completely and thereafter heating the sheets to dry them.

21. A method of obtaining a bond between a surface of fibrous material and a surface of water-setting cementitious material in the plastic or unset state which comprises causing the two surfaces to adhere together by means of an adhesive comprising an aqueous mixture of a watersetting cementitious material with a water-soluble adhesive, said adhesive being applied as a coating to said fibrous surface.

22. A method of manufacturing composite boards which comprises treating a liner with an adhesive which comprises an aqueous mixture of a water-setting cementitious material with a water-soluble adhesive and applying it to a core of water-setting cementitious material while the latter is in the plastic or unset state.

23. A method as set out in claim 22 in which the core comprises a plaster of Paris mix.

24. A method as claimed in claim 21 in which the adhesive comprises a water-setting cementitious material in admixture with an aqueous solution of a resin syrup.

25. A method as claimed in claim 21 in which the adhesive comprises a water-soluble adhesive in admixture with plaster of Paris.

26. A continuous method of manufacturing composite board which comprises treating a liner with an adhesive which comprises an aqueous mixture of a water-setting cementitious material with a water-soluble adhesive and continuously forming a plasterboard by applying a layer of water-setting cementitious material in the plastic or unset state to a continuously advancing sheet of said treated liner.

27. A continuous method of manufacturing composite board which comprises coating a continuously advancing liner sheet with an adhesive comprising an aqueous mixture of plaster of Paris with between 5 and 20 per cent, calculated on the weight of the plaster of Paris, of a water-soluble adhesive selected from the class consisting of gum arabic, dextrine and karaya gum, and applying a core layer of plaster of Paris in the plastic or unset state to said coated liner sheet while it is being advanced.

28. The method of manufacturing composite boards which comprises treating a liner with an adhesive which comprises an aqueous mixture of plaster of Paris with a water-soluble adhesive selected from the group consisting of gum arabic, dextrine, karaya gum, starch, gum tragacanth, water-soluble cellulose derivatives, urea formaldehyde syrups, and thiourea formaldehyde syrups, and applying said liner to a core of plaster of Paris while the latter is in a plastic state.

29. A plasterboard comprising a core of water-setting cementitious material firmly bonded to a fibrous liner by means of an adhesive comprising an aqueous mixture of a water-setting cementitious material with a water-soluble adhesive, said adhesive forming a coating over said fibrous liner.

30. A plasterboard comprising a core of water-setting cementitious material firmly bonded to a fibrous liner by means of an adhesive comprising an aqueous mixture of a water-setting cementitious material with a resin syrup, said adhesive forming a coating over said fibrous liner.

31. A plasterboard comprising a core of water-setting cementitious material firmly bonded to a fibrous liner by means of an adhesive comprising an aqueous mixture of a water-setting cementitious material with a resin syrup of the class consisting of urea formaldehyde resin syrups and thiourea formaldehyde resin syrups, said adhesive forming a coating over said fibrous liner.

32. A plasterboard comprising a core of set plaster of Paris firmly bonded to a fibrous liner by means of an aqueous adhesive comprising a mixture of plaster of Paris and a water-soluble adhesive selected from the class consisting of gum arabic, dextrine and karaya gum in amount lying between 5 and 20 per cent by weight calculated on the weight of the plaster of Paris, said adhesive forming a coating over said fibrous liner.

JOHN BRISCOE SANDFORD.
VICTOR LEFEBURE.