

UNITED STATES PATENT OFFICE.

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IMPROVEMENT IN THE MANUFACTURE OF PAPER.

Specification forming part of Letters Patent No. 105,591, dated July 19, 1870.

To all whom it may concern:

Be it known that I, HENRY PEMBERTON, of Allegheny City, State of Pennsylvania, have invented a new and useful Improvement in the Manufacture of Paper; and I do hereby declare the following to be a full, clear, and exact description of the same, which will enable others skilled in the art to which it appertains to practice my invention.

In manufacturing many varieties of paper, it is desirable to incorporate into the texture of the paper a greater or lesser amount of non-organized or mineral matter, partly for the purpose of cheapening the fabric thus produced by the substitution of the cheaper non-organic material for the more expensive organic tissue, and partly for obtaining a harder, firmer, and more opaque paper than can be produced when the comparatively soft, elastic, and transparent vegetable or animal fibers are alone made use of.

The substances thus employed (apart from alum, rosin, and other sizings, whose action is superficial only) may be divided into two classes—first, those natural or artificial inorganic materials the structure of which is either amorphous, or, if crystalline, consisting of extremely minute crystals, whose transverse and conjugate diameters are equal, or, at least, approximatively so. Under this category may be ranked all the varieties of clay, china-clay, silicious earths, precipitated silica, all minerals artificially ground, (whether levigated or otherwise,) and some varieties of sulphate of lime. These materials, though generally insoluble in water, and possessing the desirable shade or absence of color, are yet in other respects very imperfectly adapted to the requirements of the paper-makers, since their particles, if in a sufficiently fine state of division to be fitted for incorporation into the body of the paper, are, owing to the absence of all fibrous structure, incapable of being properly interwoven through and among the fibers of the organic tissues that constitute the pulp of true paper. Consequently these mineral matters are only imperfectly taken up by the fibrous pulp with which they are mechanically agitated, a large proportion, often seventy-five (75) per cent. of the quantity used, escaping through the meshes of the wire-gauze in the

paper-machines upon whose surface the web of fibrous tissue is deposited, while the non-fibrous earthy matter is carried away, in great part, by the escaping water. A portion of the mineral substances is, however, retained by the paper. Even this portion, however, is so imperfectly entangled among the tissues of the paper that it readily dusts out, particularly from unsized printing-paper, and becomes a source of great annoyance and injury to the printer, besides rapidly wearing down the faces of the type, owing to the hard and gritty or sandy character of the molecules themselves.

Second, those mineral substances that possess a fibrous texture, or, more properly speaking, the crystalline particles of which are needle-like or prismatic, constituting what are known as "silky crystals." There are but few natural minerals possessing this structure, (asbestos being one,) and of the few that are found, the necessary mechanical treatment to which they are subjected to cleanse and disintegrate them deprives them of the fibrous character by breaking or grinding up the needle-like crystals.

It is therefore only by artificial or chemical means that it becomes possible to obtain non-organic matters that possess, with the required cheapness, whiteness, purity, and fine state of division, also the desired fibrous crystalline condition. These conditions are combined in the crystals of hydrated sulphate of lime, ($\text{CaOSO}_3 + 2\text{HO}$), which are obtained either from the natural sulphate (gypsum) by calcination and subsequent hydration under the circumstances appropriate for the formation of a finely-divided crystalline powder, (*terra alba*), or by precipitation from a soluble salt of lime by sulphuric hydrate, or by some other soluble sulphate. The latter form of the calcic sulphate is particularly adapted to the fabrication of paper, and has, in common with other cheaper but less-fibrous forms thereof, become an important article of commerce. Much disappointment has arisen, however, when these preparations have been employed by paper-makers, by the yield of paper being very far below what should have been produced from the sum of rag or other pulps used and of the calcic sulphate added, notwithstanding that

the water escaping from the engine was perfectly clear, and free from all traces of suspended particles, while, under the same circumstances, if China clay had been used in place of the sulphate, the water would have been very milky, and loaded with finely-divided and suspended clay, the loss of which would be evident.

This disappointment and loss by the use of the calcic sulphate arises, however, from a different cause—viz, the solubility of sulphate of lime in water, by which a large quantity of the sulphate is removed from the pulp, and is lost, quite or absolutely, as if it had possessed no fibrous structure, one part of it being soluble in about four hundred and fifty (450) parts of water. This loss has prevented, to a great extent, the employment of the above salt, that, in other respects, possesses every requisite to recommend it to the paper-maker.

I have invented a means by which this loss can be avoided, and for which invention I ask that Letters Patent may be granted to me.

My invention is essentially as follows:

It is a well-known principle in chemistry that, when a substance is brought in contact with water or other fluid for which it possesses chemical affinity, (or solubility,) the fluid in question will unite with or dissolve only a certain quantity. After this quantity is dissolved, the remainder, in however great excess it may be to the fluid in question, remains, and behaves precisely as an insoluble substance would do if brought in contact with the said fluid. If, therefore, a saturated solution of sulphate of lime was employed in place of pure water in effecting the admixture of the fibrous sulphate with the paper-pulp proper, it is evident that no further loss of calcic sulphate by solution could occur.

My invention consists in employing, in the manufacture of paper, wherein sulphate of lime enters as an ingredient, the saturated or partly-saturated solution of sulphate of lime in place of ordinary water, whether the said solution is obtained by collecting the water escaping from the paper-machines, (in which calcic sulphate has been used or employed a second time,) or by purposely and intentionally making in a separate vessel a saturated or partly-saturated solution of sulphate of lime, and then using the same, or by producing in the "hollander" or other part of the paper-machine a saturated or partly-saturated solution of calcic sulphate by adding some other and cheaper form of sulphate of lime, so as to saturate, in part or whole, the water used in the manufacture of the paper before the introduction of the more expensive and more fibrous artificially-prepared sulphate of lime. All or any of these methods produce the same results, and I claim the use of all or any of them, as circumstances may render most expedient.

In order to permit others skilled in the art to avail themselves of my invention, I will now describe the method I prefer to use in de-

tail, without, however, confining myself thereto, but making use of any of the above-described plans as may be most expedient.

I first prepare a large tank or other reservoir of such capacity as may furnish a full and ample supply of water for the use of the paper-machines, hollanders, and other apparatus, (preferring, however, not to use the contents of said reservoirs for the supply of the steam-boilers, nor for the solution and preparation of the soda or alkaline solutions used in the manufacture of paper.

To such a reservoir (being empty) I adapt a small agitating-tank, with such stirring machinery therein as may serve to keep its contents in brisk intercommunication, and so that its contents may be slowly but uniformly discharged into the larger reservoir, and through which all the water entering the larger reservoir must pass. Into this smaller tank, being filled with water, I introduce, in fine powder, sulphate of lime, either in the form of ground gypsum, (native,) or, preferably, calcined ground plaster-of-paris, in the proportion of one pound of sulphate to every six (6) cubic feet of water entering said tank. This proportion may be decreased after some time, according to the size of the reservoir and to the amount of deposit of undissolved sulphate that has accumulated on the bottom thereof; but it should never be less than one pound of sulphate to four hundred pounds of water. After the reservoir is filled it should be left at rest until the undissolved sulphate has had time to settle, when the clear solution may be drawn off and used. Or the sulphate may be introduced in lumps into the reservoir, and so used.

For some purposes it may be more convenient to add to the water in the hollander the requisite quantity of calcic sulphate, either in the form of ground plaster, or, for better qualities of paper, in the form of *terra alba*, before the introduction of the more expensive and more fibrous variety of sulphate; or all the water escaping from the machines may be collected in a suitable reservoir and returned to the original reservoir and be worked over and over again. These modifications may be rendered desirable by circumstances; but I give the preference to the plan hereinbefore described.

By the use of this process it is easy to incorporate fifty pounds of the fibrous sulphate with one hundred pounds of rag-pulp, and to obtain therefrom one hundred and fifty pounds of excellent paper, whereas, without the use of my invention, not over one hundred and five pounds, or at the utmost one hundred and ten pounds, would have been produced. For making inferior quality of paper, as much as pound for pound can be used to advantage.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

The application of a saturated or partly-

saturated solution of sulphate of lime to the manufacture of paper wherein sulphate of lime, under any name, enters as an ingredient, whether said solution has been prepared, first, previously in a separate vessel or reservoir, or, second, obtained by the introduction into any part of the process of a cheaper or less fibrous form of sulphate previous to the introduction of the more fibrous and more ex-

pensive form of the sulphate desired to be incorporated, or, lastly, by the recovery and reuse of the saturated or partly-saturated solution of sulphate of lime that has already passed through and escaped from the apparatus.

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Witnesses:

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