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METHOD OF PRODUCING SIZED PAPERS

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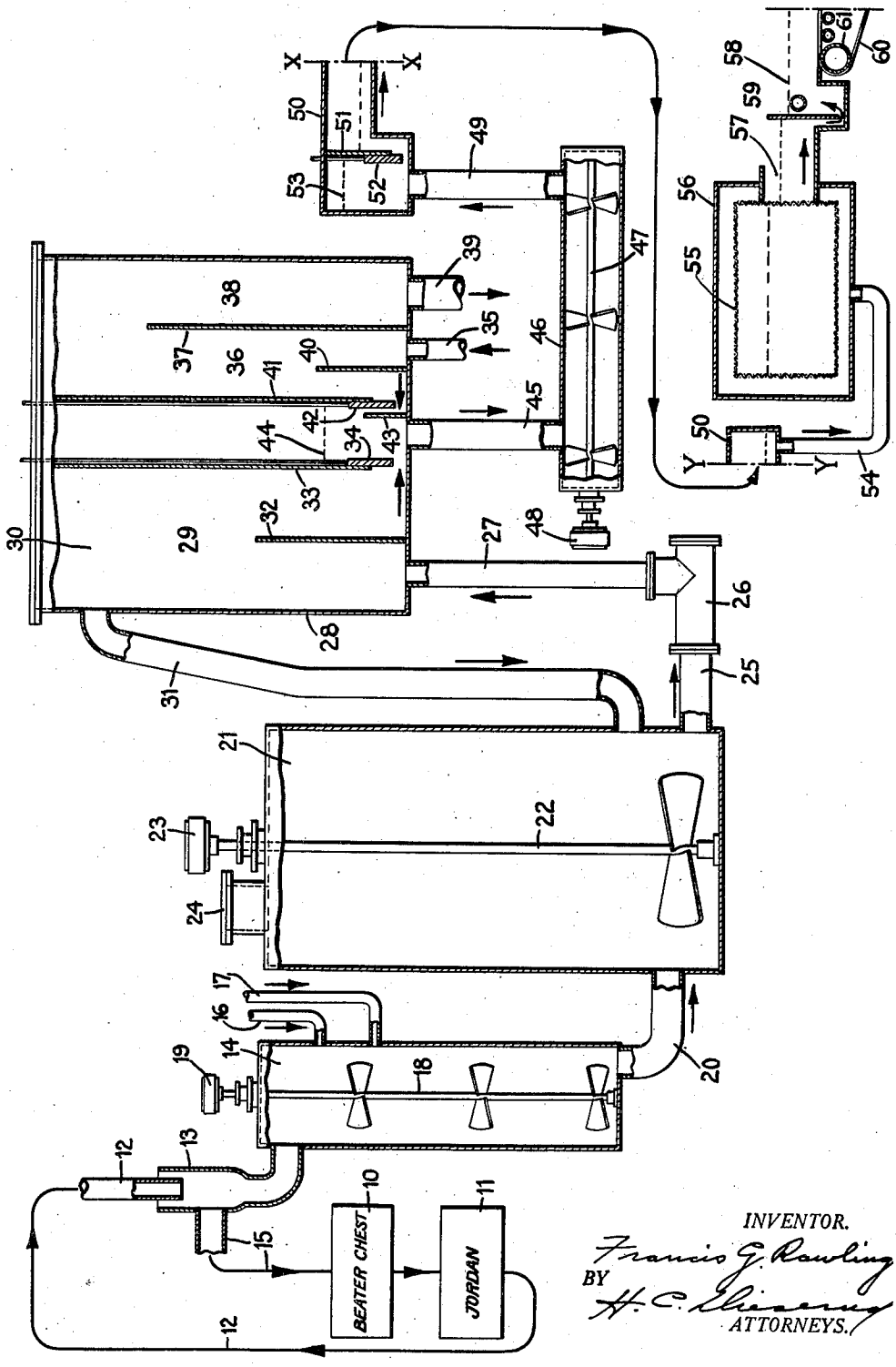

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METHOD OF PRODUCING SIZED PAPERS

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This invention relates to the production of sized papers having a finely divided filler composed in large part or in whole of a calcium salt such as chalk or calcium carbonate. The improved method may be employed for other purposes, as well, where problems are encountered similar to those involved in the production of such papers.

The difficulties involved in the sizing of chalk filled paper and the like by the use of the common sizing ingredients, such as rosin and alum, have long been recognized. Various proposals have been made for overcoming these difficulties but these have up to the present met with only partial success. The foaming of the stock and deleterious effect upon the paper produced has not been entirely eliminated. Some reduction of the objectionable foaming may be brought about by introducing the filler or the sizing ingredients, or the precipitating agent such as alum, at a late stage i. e. just before the stock is delivered to the wire of the paper machine. This reduces to a minimum the time available for reaction between the acid ingredients of the size and the alkaline ingredients of the filler. At the same time, however, the late introduction of one or more of these substances or the late precipitation of the size prevents thorough incorporation or distribution of the substances throughout the stock and prevents proper setting of the size so that the resulting sheet lacks homogeneity and other desirable characteristics.

I have discovered that objectionable foaming may be eliminated by the exercise of appropriate precautions even though the sizing constituents and alkaline filler are both added at a sufficiently early point to insure thorough intermixture with the paper stock and to allow ample time for the size to set, say 30 minutes or so. These precautions involve the handling of the stock, after the reacting ingredients have been added, in such a way that the gas, such as carbon dioxide, developed upon the reaction is retained in solution in the water of suspension. This may be accomplished in various ways. A sufficient quantity of the gas should be retained to impart to the pulp suspension a pH value of less than 7.0 and preferably below 6.6. An important consideration is that the stock should not be agitated or handled under conditions permitting or facilitating the escape of any appreciable portion of the gas into the atmosphere. It will be appreciated that in operations in which carbon dioxide is generated as the result of a reaction between the acidic precipitant, such as alum, and a carbonate filler, such as chalk, the pH of the mixture will be below 7.0 due to the presence of the acidic precipitant and it is the purpose of the invention in this case to maintain the pH below 7.0 by the retention of the major part of the generated carbon dioxide.

Carbon dioxide is soluble in water to only a very limited extent, i. e. about 1.26 grams per liter at 30° C. and 760 m. m. of mercury pressure. When it is considered that the vapor or partial pressure of carbon dioxide in ordinary atmospheric air is only about 0.3 m. m. of mercury it will be appreciated that the amount of this gas which remains in solution in water exposed to the atmosphere is very small indeed. Now if we assume that a slush pulp as delivered to the slices at a consistency of 1% contains for each 60 parts of dry fiber about 34 parts of chalk, two parts of resin size and four parts of alum, there will be generated about 0.6 part of carbon dioxide in the slush if sufficient time is allowed for reaction between the chalk and alum. The concentration of the carbon dioxide will then be around 0.06 gram per litre. This is equivalent to a vapor pressure of about 36 mm. of mercury. Since, as stated before, the vapor pressure of carbon dioxide in ordinary air is about 0.3 mm. of mercury it will be seen that there will be a considerable tendency for the carbon dioxide to escape from the slush into the atmosphere, due to the great partial pressure differential between the gas in solution and in the atmosphere. If the carbon dioxide is permitted to escape from the slush continuously during a reasonable setting period for the size, about 30 minutes, the partial pressure in the solution will just about reach that in the atmosphere, so there will then be a very small amount of the gas left in solution. The loss of the gas into the atmosphere will be accelerated, furthermore, by the agitation of the pulp as it is exposed to the atmosphere. Vigorous agitation is normally required to bring about the proper intermixture of the various constituents.

Now, I have found that it is desirable to have in solution in the pulp suspension about as much carbon dioxide as is normally generated under the conditions mentioned, i. e. about 0.06 gram per litre. This will impart to the slush a pH value of about 6.6 or lower so that it is distinctly on the acid side. Objectionable foaming is substantially eliminated when the pulp is in this state. It is undesirable to allow the pH value of the slush to rise above about 6.8 as it passes onto the wire or wet end of a paper machine and it is dis-

tinctly bad to allow it to rise above 7.0 at this point.

The retention of a suitable quantity of gas in solution may be effected in various ways. The simplest procedure is to close to the atmosphere the equipment through which the pulp is passed and particularly those vessels in which the stock is agitated in the course of delivery to the paper machine following the addition of the alum and chalk or equivalent ingredients. By closing the vessels, and particularly by maintaining the flow of stock through the system in such a way that little or no gas space is provided at the tops of the vessels, it becomes a relatively simple matter to so increase the partial pressure of the carbon dioxide in any gas accumulated above the stock that it will equal the partial pressure of 36 m. m. normally generated within the stock. A small amount of carbon dioxide may escape from the slush at the beginning of the operation but after the partial pressure of the carbon dioxide in the various vessels has been brought to the point indicated, the further escape of free carbon dioxide will be prevented. If desired, the escape of the gas at the outset may be eliminated by introducing into the vessels a sufficient quantity of carbon dioxide from some outside source to create the desired partial pressure condition. In fact if it should be desired to cause a greater amount of carbon dioxide to enter and remain in solution, than is normally generated by the reaction between the alum and chalk, an additional amount may be forced into the slush and maintained by an appropriate increase in the partial pressure of the gas in the vapor space. Other methods or means might be employed for preventing the escape of the generated carbon dioxide or similar gas from the pulp. For example, the upper surface of the mass in any of the mixing or storage tanks might be blanketed with foam of suitable character to avoid exposure of the mass to the atmosphere. Any convenient arrangement might be provided for maintaining an atmosphere with carbon dioxide under a partial pressure of from 40 to 50 mm. or more above the surface of the slush.

Having now explained in a general way the improved method of preventing the development of deleterious foam in pulp containing chalk or the like and the usual sizing ingredients, a detailed description of suitable apparatus for the conduct of the process will be given in conjunction with the accompanying drawing, which illustrates schematically that portion of paper making equipment that is most suitably modified for the purposes of the invention.

Referring now to the drawing, there is shown diagrammatically a beater chest **10** arranged to deliver stock to a Jordan **11**. It will be understood that these are of any conventional construction and are arranged in the usual way in relation to other equipment required in the preparation of pulp for delivery to the wire of a paper machine. From the Jordan **11** the pulp may be passed through a pipe **12** to a reservoir **13** forming the inlet to a mixing chamber **14**. The reservoir **13** is preferably connected into the mixing chamber at a point near the top of the latter and extends upwardly on the outside to a point above the top of the chamber. The reservoir should normally be kept filled up to the level of a discharge pipe **15** by means of which surplus stock is returned to the beater chest.

Suitable means, such as inlet pipes **16** and **17**, are provided for the introduction of rosin and alum and a chalk suspension, respectively, into the mixing chamber. The introduction of these constituents may be regulated in any suitable way to insure the production of an appropriate mixture in the chamber. An agitator **18**, driven in any convenient manner, as by means of a pulley **19** connected with an appropriate source of power, serves to thoroughly mix the pulp, sizing ingredients, and filler. The top of the chamber may be provided with a suitable stuffing box to form a seal around the agitator shaft, particularly if it is desired to maintain a slight pressure within the chamber. As the materials are being agitated, they gradually move toward the bottom of the mixing chamber and are discharged through a pipe **20** into the bottom of a machine chest **21**.

The machine chest differs from the conventional type in that it is closed at the top to prevent the escape of generated carbon dioxide into the atmosphere. An agitator **22**, driven in any convenient way, as by a belt connected with a pulley **23**, is preferably provided to continue the stirring and intermixing of the various ingredients. The shaft of this agitator may also be provided with a stuffng box at the top of the chest, if desired. At one side of the top of the machine chest a manhole, normally closed by a cover **24**, may be provided to facilitate the cleaning and repair of the chest whenever this becomes necessary. It is desirable that the machine chest should have a capacity sufficient to allow the stock to remain in it for about 30 minutes or even longer. This will afford ample time for the setting of the size.

A pipe **25** connected to a suitable outlet opening near the bottom of the machine chest serves to deliver the slush to a pump **26** by which it is forced through a pipe **27** into a head box **28**. The mixture is delivered into a chamber **29** within the head box and is maintained at a suitable level, as indicated at **30**. Excess pulp delivered into the chamber **29** is returned to the machine chest by means of a pipe **31** entering the chest, preferably at a point near the bottom. As indicated, the pipe **31** is inclined somewhat to the vertical down to a point slightly below the top of the machine chest to avoid building up a hydraulic head in the chest. The inclination may be somewhat greater than shown, for this purpose. Should it be desired to maintain a slight pressure within the chest this might be accomplished by so arranging the chamber **14** and the head box with its return connection **31** as to introduce the material into the chest under the desired pressure. The head box should be closed at its top, as indicated, so as to prevent the escape of carbon dioxide or other gas into the atmosphere. A baffle-plate **32** is preferably provided at an intermediate point within the chamber **29** to prevent direct communication between the inlet and outlet of this chamber and the production of turbulence. The outlet is provided beneath a partition **33** which extends down from the top of the head box to a suitable point above the bottom. The size of the opening so provided may be conveniently adjusted to regulate the flow of pulp by means of a gate **34** made adjustable in any convenient way, as by attachment to the rods indicated.

Water for the further dilution of the pulp is introduced into the head box through a pipe **35** that discharges through the bottom of the box into a chamber **36**. For this purpose white water drained from the pulp at the paper machine may conveniently be employed. A partition **37** ex-

tending upwardly to an appropriate point above the bottom of the head box serves to regulate the level of the water in the chamber 29 and thus maintain a desired head. Excess water is discharged over the partition into the chamber 38, from which it is withdrawn by means of a pipe 39 and disposed of in any convenient way, preferably for recirculation through the system. Baffle-plate 40, extending upwardly from the bottom of the head box, prevents the direct delivery of water from the pipe 35 to the outlet of the chamber 36 and the creation of turbulence. A regulated amount of water is delivered from the chamber 36 into the intermediate mixing compartment of the head box through an opening at the bottom of a partition 41 controlled by a gate 42, adjustable in any convenient way. A baffle-plate 43 is preferably provided to avoid the production of turbulence within the mixing compartment as the pulp is delivered from the chamber 29 and the water from the chamber 36. The rate of introduction of the pulp and water is so regulated as to maintain the mixture at a suitable level, as indicated at 44. By appropriate adjustment of the gates 34 and 42, it is possible to maintain this level and also the proper ratio between the pulp and water to provide the desired consistency. It will be understood that these controls might, if desired, be automatically effected by the provision of a consistency regulator at a suitable point in the system.

From the bottom of the mixing compartment of the head box the mixture is delivered through a pipe 45 to an enclosed mixing chamber 46 provided with an agitator 47 driven in any convenient way, as by means of a pulley 48. In passing through the mixing chamber 46, the water and pulp are thoroughly intermixed so that a suspension of uniform consistency is discharged through a pipe 49 to a riffle box 50. The arrangement of the mixing chamber and riffle box in relation to the head box is such that a natural flow is provided to and through the riffers. A baffle 51, having associated therewith a gate 52, serves to conveniently control the flow of the mixture through the riffle box and to maintain a liquid level, as indicated at 53, at the head of the riffle box.

At the discharge end of the riffle box the pulp is delivered by means of a pipe 54 to a screen 55. The latter is completely enclosed by a chamber 56 so as to prevent the escape of carbon dioxide into the atmosphere. It will be understood that in this way the partial pressure of the carbon dioxide in the vapor space above the liquid level in the screen may be maintained at such a point that there will be no tendency for the carbon dioxide in the pulp to escape. The screen may otherwise be of conventional design and may be arranged to discharge the screened pulp through an opening 57 into a flow box 58 of a paper machine. A baffle 59 may conveniently be provided to regulate the flow of the pulp to the wire or apron 60 of the machine as the wire passes around the breast roll 61. From this point on the operation may be conducted in the usual way to form a continuous web of paper, although, if desired, the gas may be retained as much as possible in the white water drained from the pulp at the paper machine by exercising similar precautions in the handling of this water. Furthermore the entire wet end of the paper machine might be enclosed and an atmosphere rich in carbon dioxide or the like maintained around the web as it is formed. This, however, is not actually necessary since the time element involved is so brief that an appreciable amount of gas will not ordinarily escape in the formation of the web. It will be found that no deleterious foaming will take place, as the result of the handling of the pulp in the manner indicated without modifying the paper machine itself.

The foregoing equipment may conveniently be so arranged and operated that the pulp substantially fills the mixing chamber and machine chest so that very little space is available for the accumulation of air or gas. The gas space above the pulp in the head-box, riffle-box and screen may also be reduced to a minimum to limit the escape of gas from the stock. However, this is not altogether essential since, as has been previously stated, the escape of carbon dioxide from the pulp mixture may readily be inhibited by introducing an atmosphere rich in carbon dioxide into the upper portions of each of the enclosed devices mentioned, from the mixing chamber 14 to the wet end of the paper machine. For this purpose a suitable inlet pipe may be provided at the top of the mixing chamber, machine chest, head-box, riffle-box, and screen, and these inlets may be connected to any suitable source of carbon dioxide or gas rich in carbon dioxide as, for example, flue gas or lime kiln gas. If this expedient is employed the gas space above the stock in each vessel may be as large as desired since the partial pressure of the carbon dioxide or similar gas in this gas space may be readily maintained above that of the gas in solution so that none will escape. In lieu of introducing carbon dioxide from a separate source sufficient acid may be added to the pulp to insure the generating of an ample quantity of the gas. If it is desired to retain as much gas as possible in solution in the white water the save-alls and the like may, in addition to being enclosed, be provided with inlets for the introduction of a gas rich in carbon dioxide or whatever gas is to be retained.

In lieu of providing the screen 5 at the point indicated beyond the riffle box, the screening might be effected after the Jordaning of the pulp and prior to the introduction of the sizing ingredients or filler or both. If this is done it will be unnecessary to completely enclose the screen or to take any other precautions to maintain an atmosphere of carbon dioxide above the liquid in the screen.

It will be apparent that the construction and arrangement of apparatus as described enables the thorough intermixture of the fibers, sizing ingredients and filler and the allowance of ample time for the setting of the size without the attendant loss of carbon dioxide from solution and hence without permitting the pH value of the suspension to rise above the point at which objectionable foaming begins to take place.

While the preferred method of procedure and a preferred form of equipment have been described in considerable detail, it will be understood that numerous variations may be made in the conduct of the process and in the construction and arrangement of the equipment without departing from the general spirit and scope of the invention. It has been indicated as desirable to introduce the filler at the mixing chamber. It might well be added at an earlier or later stage although if any considerable amount is added, say more than 10% of the weight of the dry fibre, it is best not to mix it with the pulp until after the latter is fully beaten. Furthermore it will not become uniformly distributed if added too late i. e. beyond the machine chest for exam-

ple, particularly if a large amount is used, such as 20 to 35%. Moreover, while the invention has been explained with particular reference to the foaming problems encountered in the use of chalk as a filler and alum as a size precipitant in paper, it will be understood that the invention is of broader application. It may, for example, be utilized in connection with other fillers in whole or in part and other sizing agents, the reaction between which gives rise to deleterious foaming in the course of producing paper. For example, a part or all of the rosin may be replaced by wax or rosin-wax or similar substances while the alum may be replaced in part by sulfuric acid or other acids. The pulp stock employed may be either sulfite, soda or kraft or a mixture of two or more of them or mixtures of these with other pulps according to the strength and character of paper desired. The invention may also be used to advantage under other conditions, which make it desirable to maintain a low pH value in the pulp delivered to a paper machine. In lieu of completely enclosing the various mixing and storage chambers other means may be adopted for preventing the free movement of the gases away from the surfaces of masses of pulp. The use of foam for this purpose has already been suggested herein. It will be apparent that the various covers need not be absolutely air tight. The riffle-box and head-box covers, particularly, need only be reasonably tight to prevent free movement of gases with the pressure substantially the same inside and out. Another possible variation is to place the head-box, rifflers, screens, and the wet end of the paper machine in an enclosed room having a sufficiently high carbon dioxide content in its atmosphere to prevent escape of the gas from the pulp. The various controls for the system should then be located outside of the room. I do not desire to limit myself other than by the claims which follow.

What I claim is:

1. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of mixing a pulp suspension, sizing ingredients including an acidic precipitant and filler out of communication with the outside atmosphere at a pH not above 7.0, permitting the filler and acidic precipitant to react to a limited extent and maintaining above the suspension in the course of mixing the same an atmosphere rich in the carbon dioxide generated by the reaction between the sizing ingredients and filler to thereby maintain the mixture at a pH not above 7.0.

2. A method of producing a filled and sized paper which includes the steps of thoroughly mixing in a closed vessel at a pH not above 7.0 a pulp suspension, sizing ingredients including an acidic precipitant and a filler containing a finely divided calcium salt capable of reacting with said sizing ingredients to produce carbon dioxide, permitting the filler and sizing ingredients to react to a limited extent, and maintaining the mixture out of contact with the outside atmosphere under conditions preventing the escape from said mixture of substantial quantities of carbon dioxide substantially up to the point at which it is delivered to the wire of a paper machine to thereby maintain the mixture at a pH not above 7.0.

3. A method of producing a filled and sized paper which includes the steps of thoroughly mixing in a closed vessel at a pH not above 7.0 a pulp suspension, a filler containing calcium carbonate, and sizing ingredients including alum, permitting the filler and sizing ingredients to react to a limited extent and maintaining the mixture out of contact with the outside atmosphere under conditions preventing the escape from said mixture of substantial quantities of said gas substantially up to the point at which it is delivered to the wire of a paper machine to thereby maintain the mixture at a pH not above 7.0.

4. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of intermixing a pulp suspension, sizing ingredients including an acidic precipitant and a filler, permitting the filler and acidic precipitant to react to a limited extent, and retaining in solution in the pulp suspension from which the paper is formed a sufficient portion of the carbon dioxide generated by the reaction between the acidic precipitant and filler to maintain a pH value of less than 6.8, substantially up to the point where the stock is delivered to the wire of a paper machine.

5. A method of producing sized paper having sizing ingredients precipitated by an acidic precipitant and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of permitting the filler and acidic precipitant to react to a limited extent preventing the free movement of gases away from the outer surfaces of bodies of pulp containing the acidic precipitant and filler in the course of mixing the stock and delivering it to a paper machine, and maintaining the stock at a pH not above 7.0 in the course of such mixing and delivery.

6. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of mixing a pulp suspension, sizing ingredients including an acidic precipitant and filler of the character specified at a pH not above 7.0 and passing the same through a series of vessels to a paper machine, permitting the filler and sizing ingredients to react to a limited extent and maintaining a substantially motionless atmosphere rich in the carbon dioxide being generated by the reaction between the filler and sizing ingredients above the surface of the stock in the course of mixing the same and passing it to the paper machine to thereby maintain the mixture at a pH not above 7.0.

7. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of mixing a pulp suspension, non-gaseous sizing ingredients including an acidic precipitant and a filler of the character specified at a pH not above 7.0 for a period of not substantially less than 30 minutes, and permitting the filler and sizing ingredients to react to a limited extent while maintaining the major portion of the carbon dioxide generated by the reaction between the sizing ingredients and filler in solution in the pulp suspension from which the paper is formed to thereby maintain the mixture at a pH not above 7.0.

8. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of mixing a pulp suspension, sizing ingredients including an

acidic precipitant and a filler of the character specified at a pH not above 7.0 for a period of not substantially less than 30 minutes, and permitting the filler and sizing ingredients to react to a limited extent while maintaining most of the carbon dioxide generated by the reaction between the sizing ingredients and filler in solution in the pulp suspension from which the paper is formed to thereby maintain the mixture at a pH not above 7.0, and passing the stock out of contact with the outside atmosphere to the wet-end of a paper machine.

9. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of mixing a pulp suspension, sizing ingredients including an acidic precipitant and filler of the character specified at a pH not above 7.0 in a closed vessel substantially filled with the constituents being mixed and allowing the acidic precipitant and filler to react to a limited extent to generate carbon dioxide which is retained in the pulp suspension by virtue of the substantial absence of gas space above it and thereby maintains the suspension at a pH not above 7.0.

10. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of mixing a pulp suspension, sizing ingredients including an acidic precipitant and filler of the character specified at a pH not above 7.0 in a closed vessel substantially filled with the constituents being mixed and allowing the acidic precipitant and filler to react to a limited extent to generate carbon dioxide which is retained in the pulp suspension by virtue of the substantial absence of gas space above it and thereby maintains the suspension at a pH not above 7.0, introducing and withdrawing the constituents and mixture, respectively, at a rate allowing not substantially less than 30 minutes for the setting of the size, and passing the mixture out of contact with the outside atmosphere to the wet end of a paper machine.

11. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of intermixing a pulp suspension, non-gaseous sizing ingredients including an acidic precipitant, and a filler at a pH not above 7.0, permitting the filler and sizing ingredients to react to a limited extent, and maintaining the major portion of the carbon dioxide generated by the reaction between the sizing ingredients and filler in solution in the pulp suspension substantially until it is formed into a web of paper to thereby maintain the mixture at a pH not above 7.0.

12. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of mixing a pulp suspension, sizing ingredients including an acidic precipitant, and filler in a closed vessel at a pH not above 7.0, permitting the filler and sizing ingredients to react to a limited extent, and maintaining the mixture out of contact with the atmosphere and in the presence of the carbon dioxide produced under a vapor pressure a number of times greater than in an average normal atmosphere up to the point at which it is delivered to the wire of a paper machine.

13. A method of producing sized paper having sizing ingredients and a filler naturally reacting to produce carbon dioxide and objectionable foaming which includes the steps of mixing a pulp suspension, sizing ingredients including an acidic precipitant, and filler out of communication with the outside atmosphere at a pH not above 7.0, permitting the filler and sizing ingredients to react to a limited extent, and maintaining the mixture out of contact with the atmosphere and in the presence of the carbon dioxide produced substantially up to the point at which it is delivered to the wire of a paper machine to thereby maintain the mixture at a pH not above 7.0.

14. A method of producing a filled and sized paper which includes the steps of thoroughly mixing in a closed vessel at a pH not above 7.0 a pulp suspension, sizing ingredients including an acidic precipitant, and a filler containing a finely divided calcium salt capable of reacting with said sizing ingredients to produce carbon dioxide, permitting the filler and sizing ingredients to react to a limited extent to produce said carbon dioxide, and preventing the escape from said mixture of substantial quantities of said carbon dioxide to thereby maintain the mixture at a pH not above 7.0.

15. A method of producing a filled and sized paper which includes the steps of thoroughly mixing in a closed vessel at a pH not above 7.0 a pulp suspension, a filler containing calcium carbonate, and sizing ingredients including alum, permitting the carbonate and alum to react to a limited extent to produce carbon dioxide, and preventing the escape from said mixture of substantial quantities of the carbon dioxide so generated to thereby maintain the mixture at a pH not above 7.0.

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