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TRAITEMENT DE MATIERES FIBREUSES

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Description

The present invention relates to a method of sizing fibres particularly but not exclusively cellulosic fibres) in an aqueous suspension thereof, the sized fibres being used in the production of paper. The invention also relates to papermaking apparatus.

The term paper as used herein is generic to paper, paperboard, and like fibrous sheet materials which are generally (but not necessarily) of a cellulosic nature.

In essence, the process for manufacturing paper comprises preparing a suspension of fibres (usually cellulose fibres) from which the paper is to be produced and then passing this suspension along suitable conduit to a papermaking wire or former (hereinafter referred to generically as a wire) on which the suspension is deposited. A vacuum is applied to that side of the wire opposite to the side on which the suspension is deposited so that water is drawn through the wire to leave a sheet of the fibres which may then be further dried and processed as required.

Various additives are required for this process. In particular, paper sizing agents are frequently added to the suspension. Examples of such paper sizing agents are rosin emulsions which are used in conjunction with alum (or other simple or polymeric aluminium salts). Further examples are cationic polymer and rosin emulsion mixtures, see for example GB-A-2,141,751. Other combinations of sizes and fixers are also used.

So far as the sizing of fibres with a rosin emulsion in conjunction with alum (ie. aluminium sulphate) is concerned, the alum is effective under acid conditions to break down the emulsion and cause the rosin to be deposited on the particulate material which constitutes the furnish (i.e. fibres and any filler present). Conventional practice is for the rosin emulsion (pH ca 7) and alum solution (pH less than 3) to be added separately to the suspension of cellulose fibres from which the paper is to be prepared.

Conventionally, the additions of rosin and alum solution are made at separate locations along a pipe through which the fibrous stock is flowing. In particular, the alum solution is normally added to the pipe considerably upstream of the rosin emulsion.

The amount of alum solution added will generally be such as to provide a pH of 5 to 5.5 in the suspension prior to the addition of the rosin emulsion. This degree of acidity is required in the suspension so that the rosin is deposited and retained on the cellulose fibres.

However, this acidic pH may cause problems if the fibrous stock has been produced at least partly from waste paper which incorporates calcium carbonate or when calcium carbonate is added as a filler. In this case, the calcium carbonate gives rise to deposits of calcium sulphate. Such deposits build up over a period of time cause blockage of the various lines in the plant and, more importantly, in the apertures of the foraminous wire on which the paper is formed. The process must therefore be periodically shut down so that the blockages may be cleared. Obviously this is a considerable disadvantage. The use of pH conditions close to neutrality is not possible because the rosin is not sufficiently deposited or retained on the fibres. This is a significant disadvantage of sizing with rosin emulsions.

The formation of calcium sulphate deposits may be avoided by the use of reactive sizes, for example, alkyl ketene dimer (AKD) sizes, in place of the rosin and alum. However, AKD sizes are not the ideal solution when it is desired to produce paper on a MG (machine glaze) machine since MG cylinder adhesion is frequently lost and furthermore AKD produces only a poor finish on such machines.

We now believe that the abovementioned limitations of rosin-alum sizing result from the way in which the rosin and alum are introduced into the fibre suspension in the prior process, and that these limitations are overcome by using the procedures set out below which involve rapid mixing of rosin emulsion and alum solution streams and the incorporation of a localised zone (of relatively high concentration) in the fibre suspension. The rosin emulsion/alum solution system is an unstable system in that a mixture of these two components will normally flocculate, but using the rapid mixing procedures set out below a rosin emulsion/alum solution mixture may readily be incorporated in the suspension without problems resulting from flocculation.

According to a first aspect of the present invention there is provided a method of sizing fibres in an aqueous suspension thereof, the method comprising:

- a. providing an aqueous suspension of fibres having a pH of at least 6,
- b. passing the aqueous suspension of fibres through a stock pipe,
- c. impinging upon each other turbulent, discrete streams of an aluminium salt solution and a rosin emulsion to effect mixing of the streams and provide a freshly prepared mixture of the aluminium salt and the rosin emulsion which is at an acidic pH less than that of the suspension of step a,
- d. providing the freshly prepared mixture in the fibre suspension at a substantially central region of the stock pipe to form a localised zone of the freshly prepared mixture, and
- e. causing the freshly prepared mixture to be dispersed within the suspension whereby the mixture undergoes a pH transition which is effective to cause rosin to be deposited on the fibres.

According to a second aspect of the present invention there is provided papermaking apparatus comprising suspension preparation means for preparing a suspension of fibres, a foraminous wire on which the suspension is deposited for preparing the paper, and a stock pipe for conveying the suspension between the suspension preparation means and the wire wherein provided along the stock pipe is a mixing assembly having two inlets into which separate streams of a rosin emulsion and an aluminium salt solution to be mixed can be supplied and having an outlet region located substantially centrally within the stock pipe at which the localised zone of a mixture of the additives is provided.

The fibres to be treated will generally be cellulose fibres and the invention will be specifically described with reference to such fibres. It should however be understood that the invention is also applicable to the sizing of other types of fibres from which paper may be prepared.

The fibre suspension will itself be a flowing stream within the stock pipe and the localised zone of the freshly mixed solution of the aluminium salt and rosin emulsion is provided in the fibre suspension stream by the methods described in more detail below. The localised zone is distributed within such a fibre suspension stream by the flow thereof. The pH of the localised zone in the suspension may as a matter of practice be difficult to measure. However the pH of the suspension itself (prior to mixture with the rosin emulsion (aluminium salt solution)) is easy to measure and it is simply necessary to ensure that a mixture of the rosin emulsion/aluminium salt solutions will be of an acidic pH less than that of the fibre suspension. In this way, it is ensured that the localised zone of the mixed rosin emulsion/aluminium salt solution will be at an acidic pH less than that of the fibre suspension. For preference, the pH of the fibre suspension after the rosin emulsion/aluminium salt has been dispersed therethrough is above 6.5, preferably above 6.7. This ensures that no substantial calcium sulphate deposits (for the case where the fibrous stock has been produced at least partly from calcium carbonate as a filler). Furthermore, operation at these pH values improves drainage through the wire of the paper making machine.

We have discovered that it is possible to use rosin emulsions and solutions of aluminium salts to effect sizing of cellulose fibres which are in aqueous suspension provided that the rosin emulsion and aluminium salt solution are continuously provided in the suspension as a freshly mixed localised zone which is at a pH less than that of the suspension. As this zone is distributed throughout the suspension, the rosin emulsion/alum mixture undergoes a pH transition which is effective to cause the rosin to be deposited on the fibres.

We do not wish to be bound by any particular theory as to the chemical mechanism of the sizing process of the invention but we believe that the pH transition causes the formation of polynuclear aluminium species and probably also some aluminium hydroxide precipitate (which may well be amorphous at this stage since the crystallisation process takes some considerable time) and that it is the polynuclear complexes, possibly with some contribution from precipitated aluminium hydroxide, which are responsible for the effectiveness of the invention.

The method of the invention is most preferably carried out with cellulose fibre suspensions at a pH (before admixture with the rosin emulsion/aluminium salt) of greater than 6 particularly in the range 7 to 8. The invention is also operative at virtually any normal acid pH of at least 6 for rosin sizing and up to say 9.5. This should be contrasted with the prior art process where rosin emulsion and alum solution, added at separate locations in the paper making process, are not effective for sizing cellulose fibres which are in a suspension at a pH greater than 6.

The invention thus provides the significant advantage that it may be used for the sizing, with rosin emulsion, of cellulose fibre suspensions which contain calcium carbonate and which are at a pH above 6. With such suspensions, the method of the invention does not give rise to unacceptable deposits of calcium sulphate, calcium aluminium sulphate, and related compounds in the paper machine. Any deposits formed are likely to be of a very small crystal size and are probably included in the final paper.

In contrast to the use of reactive sizes (eg. AKD sizes) which have heretofore been required for sizing suspensions with a pH above 6, the method of the invention produces paper having an excellent finish on a MG (machine glaze) machine and also an increase in running speed as compared to that obtained with AKD sizes.

The aluminium salt used in the method of the invention should preferably be an acidic salt and is most preferably alum. It is however possible to use other aluminium salts that will give rise to polyhydroxy aluminium ions and/or $\text{Al}(\text{OH})_3$, eg. polyhydroxy aluminium salts such as the compound known as polyaluminium chloride. The amount of the alum solution used will preferably be such as to provide 1-4% by weight of alum (expressed as $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$) dry basis on the fibres. Other aluminium salts may be used in appropriate amounts. For example, we have found that the amount of polyaluminium chloride used in the process may be about $1/5^{\text{th}}$ of the corresponding amount of alum required.

At least in the case where the aluminium salt is alum, the pH of a mixture of the alum solution stream and the rosin emulsion stream should for preference be below 4, more preferably about 3.8.

The method of the invention works effectively with a wide variety of rosins, eg. tall oil rosin and gum rosin. The rosin will usually have a melting point of 70-85° C. The rosin emulsion will generally comprise 20-50% solids and be used in an amount so as to provide 0.1-2% by weight (dry basis) on the fibres.

The invention will be described further with specific reference to alum as the aluminium salt, although it will be appreciated that other aluminium salts may be substituted therefor.

In one preferred method of carrying out the invention, the alum solution and rosin emulsion are intensively mixed

together immediately prior to the injection of the mixture into the stock pipe along which the suspension of cellulose fibres is flowing. Conveniently, the mixing is effected by passing the rosin emulsion and alum solution in opposite directions, and under turbulent flow conditions, along a tube which has intermediate its end an outlet communicating with the interior of the stock pipe. This mixing tube may, for example, comprise a T-piece with the rosin emulsion and alum solutions being directed (preferably under turbulent flow conditions) in opposite directions along the "bar" of the T and the resultant mixture being passed along the "stem" of the T into the stock pipe.

In another preferred way of carrying out the method of the invention, the rosin emulsion and alum solution are introduced as separate streams into the cellulose fibre suspensions flowing along the stock pipe and mixed *in situ* within the suspension. In this case, the points at which the aluminium solution and rosin emulsion are discharged into the cellulose fibre suspension flowing along the stock pipe must be sufficiently close to each other to create a mixing zone before either the rosin emulsion or alum solution is diluted too much.

Using the abovedescribed methods, the rosin emulsion/alum solution mixture is able to be incorporated in the fibre suspension without flocculation problems occurring.

It is preferable that the localised zone of the mixture of rosin emulsion and alum solution is provided in a cellulose fibre suspension which is in the form of so-called thick stock, ie. a suspension which generally contains about 3% by weight of the cellulose fibres rather than the thin stock (which will generally comprise about 1% by weight of the fibres), although this does depend on the degree of dilution in going from thick to thin stock. The invention is however applicable to the treatment of fibre suspensions containing greater or lesser amounts of fibres. However, for preference the suspension will comprise 0.1%-10% by weight of fibres, more preferably 0.2-5%.

The invention will be further described by any of example only with reference to the accompanying drawings, in which:

Fig. 1 is a diagram of aluminium hydroxide solubility as a function of pH; and

Fig. 2 is a schematic diagram of a papermaking process; and

Figs. 3 to 14 diagrammatically illustrate various types of mixing apparatus which may be used in the method of the invention.

Fig. 1 is a plot of total dissolved aluminium (A_T) vs pH and shows the stability region of freshly precipitated $Al(OH)_3$ based on the assumption that the only other species present are $Al(OH)_4^-$, $Al(OH)_2^{2+}$, its dimer $Al_2(OH)_2^{4+}$, $Al_{13}(OH)_{34}^{5+}$, and $Al_7(OH)_{17}^{4+}$, as well as the uncomplexed ion Al^{3+} . Fig. 1 is a thermodynamic diagram and may be thought of as corresponding to equilibration times longer than those normally encountered in the sizing process in a paper mill.

In the method of the invention, the mixture of rosin emulsion and alum solution which forms the localised zone in the cellulose fibre suspension preferably has a pH less than 4. The alum stocks in many paper mills contain of the order of 8% Al_2O_3 (M.Wt = 101.96), ie. approx. 0.78 mol dm^{-3} . Thus for the majority of stock found in a paper mill, the aluminium concentration is normally greater than $10^{-4} \text{ mol dm}^{-3}$ and thus greater than the minimum value of Al_T at which $Al(OH)_3$ precipitate will form. Altering the pH from its value of less than 4 to above 6 causes a move to the right on the diagram so that the system enters the insoluble region causing the formation of polynuclear complexes and precipitating some, and maybe quite a lot, of $Al(OH)_3$, probably in a gelatinous form. It is thought (R. Counter, M.J. Jaycock and J.L. Pearson, *Svensk Papperstidning* 78, 333 (1975)) that one or both of the latter two species are necessary for satisfactory sizing. Since aluminium is being precipitated from solution, the move on the diagram from the lower to the higher pH is in fact a downward diagonal move. Depending on the precise mill conditions, the final position on the solubility diagram may be inside the region corresponding to $Al(OH)_3$ or in the $Al(OH)_4^-$ region, where the concentration of polynuclear complexes will be vanishingly small, and there would be no precipitated $Al(OH)_3$. However, in the latter situation, if the point at which the localised zone of rosin emulsion/alum solution mixture is provided is moved near to where the sheet is formed, it is believed that there will not be time for the $Al(OH)_3$ to redissolve or for the polynuclear species to be converted to $Al(OH)_4^-$, so that satisfactory sizing performance can be achieved. In this respect, it should be borne in mind that Fig. 1 is a thermodynamic (and not a kinetic) diagram representing the position at equilibrium which may take some time to achieve. Thus, in the case just described, the $Al(OH)_3$ and polymeric aluminium hydroxy species (initially formed) persist long enough for sizing to take place.

Some idea of the relative lability of the polynuclear complexes can be gained from the work of R.W. Smith reported in "Nonequilibrium Systems in Natural Water Chemistry", *Advances in Chemistry Series ACS*, No. 106, p. 250 (1971). This paper states that the fastest acting species are the mononuclear ones such as Al^{3+} , $Al(OH)_2^{2+}$ and $Al(OH)_2^+$. The polynuclear species in the reported experiments had lifetimes up to one hour, and the aged precipitate $Al(OH)_3$ much longer. This work offers some support for the contention that it is the polynuclear aluminium species that are important in the process of the present invention, and hence the need to go through the relevant formation pH range in the mixing zone.

Fig. 2 is a very schematic illustration of the basic steps involved in papermaking. Within a tank 100 there is prepared a suspension of cellulose fibres which are then passed along conduit 101 to a head box 102 from which the suspension

is deposited on a wire 103 of a Foudrinier machine. Vacuum boxes 104 serve to draw water from the layer of fibres on the wire.

It should be understood that the conduit 101 shown in Fig. 2 is intended very schematically to represent the connection between the tank 100 and the head box 102. In practice, the conduit arrangement is likely to be rather more complicated than that illustrated and may include a thick stock line and a thin stock line as well as pumps for moving the suspension.

However, whatever the conduit arrangement, there is provided a mixing arrangement 105 at some point along the conduit for providing therein a localised zone of freshly mixed streams of rosin emulsion and alum solution. Various examples of such mixing arrangements are illustrated in Figs. 3-14.

Figs. 3-14 show various mixing arrangements for providing the localised zone of the mixture of rosin emulsion and alum solution in a conduit 1 along which an aqueous cellulose fibre suspension is flowing in the direction of arrow A. The conduit 1 will for preference be the thick stock pipe. In each of Figs. 3-14 the rosin emulsion is considered to be supplied in the direction of arrow B along a pipe, or pipe section, referenced as 2 and the alum solution is supplied in the direction of arrow C along a pipe, or pipe section, referenced as 3.

The mixing device of Fig. 3 is the preferred device for use in the invention and is a T-piece arrangement in which the rosin emulsion and alum solution streams impinge upon each other so that the mixture exits in the direction of arrow D along the stem of the T which is provided in the centre of the conduit 1. The mixture enters conduit 1 as a localised zone at a pH of less than 4, which then becomes dispersed throughout the cellulose fibre suspension and thus undergoes the necessary pH transition. By way of example, and as illustrated in the drawings, the pH of the fiber suspension up stream of the T-piece may be about 7-8 whereas down stream of the T-piece (and after distribution of the rosin emulsion/alum solution in the suspension) (the pH may be about 6.7).

Ideally, the flow of rosin emulsion and alum solution along the respective pipe sections 2 and 3 will be turbulent flow as this will promote more intensive and rapid mixing of the two streams. Whether the flow inside the mixer is laminar or turbulent is dependent on the Reynolds' number (Re). For a long smooth straight pipe the critical value of (Re) is usually taken as 2000, and this value may be used as a rough guide in calculating the diameters needed to produce the preferred turbulent flow conditions inside the mixer. A more detailed consideration of the conditions governing turbulent flow is given in Appendix a, and the design of a T-piece for mixing rosin emulsion and alum solution is given in Appendix b.

Fig. 4 shows a modification of Fig. 3 in which the stem of the T is omitted and the rosin emulsion/alum solution mixture simply issues through an orifice 4 into the stock pipe 1.

The mixing devices shown in Figs. 3 and 4 may be manufactured from tubing which is of a diameter specifically selected (or produced) to give the required turbulent flow conditions. The T-piece can however also be made from standard size tubing and have its bore reduced by means of inserts 5 as shown in Figs. 5-6. These inserts 5 may be bored with the right sized holes to form T-piece type configurations (Figs. 5 and 6).

Fig. 7 shows a further embodiment of T-piece type mixing device. In this case, a T-piece connector has internally threaded ends such that tubes 2 and 3 for supplying rosin emulsion and alum solution respectively may be mounted therein as shown. Also, a tube may be mounted in the stem of the T through which the mixture of alum solution and rosin emulsion exits into the suspension of cellulose fibres. The length of this latter tube may be selected having regard to the length of time for which it is desired to keep the alum solution and rosin emulsion in contact with each other before they enter the cellulose fibre suspension. If desired, or necessary, inserts 5 may be provided in the T-piece connector as shown. The illustrated insert may be formed from a single piece of tubing (one end of which is closed) simply by boring a hole transversely through the tube adjacent its closed end to obtain the configuration shown. This insert may then simply be inserted into the T-piece connector along the stem thereof.

As an alternative to mixing the rosin emulsion and alum solution together prior to their injection into the conduit 1, it is possible to create a mixing zone inside the main flowing stream of the cellulose fibre suspension, but outside the injecting pipes 2 and 3. The essence of the idea in this case is that the discharge points from the pipes 2 and 3 must be sufficiently close to each other to create a mixing zone before either injected stream is diluted very much. Figs. 8-12 show what may be considered as virtual T-pieces, where the mixing zone is created by the injections streams, and the pipe work is somewhat curtailed. Fig. 8 shows the two angled pipes 2 and 3 with their ends one behind the other so that the mixing zone occurs around the end of the downstream pipe. Straight pipe entry (see Fig. 9) into the cellulose fibre stream works just as well.

Fig. 10 shows the two pipes 2 and 3 at right angles to the walls of the conduit 1 injecting into the middle of the cellulose fibre stream so that the injected flows impinge on each other. Fig. 11 shows a similar arrangement for producing impinging streams but in which the pipes 2 and 3 are angled relative to each other. However, the arrangements of Figs. 10 and 11 are believed to be less efficient in mixing, as might be expected, and less effective from the point of view of sizing paper making performance than the T-piece of Figs. 3 and 4.

In the arrangement of Fig. 12, the end of pipe 3 locates within the end of pipe 2 so as to provide a mixing annulus.

In the mixing devices of Figs. 3 to 12 the mixture of rosin emulsion and alum solution is produced within the bounds

of the conduit 1. It is however possible to mix the rosin emulsion and alum streams externally of the stock pipe 1 and to inject the mixture into the centre of the stock pipe 1. Such an arrangement is shown in Fig. 13. The mixing process and use of inserts is covered by similar considerations to those described above for the T-piece of Fig. 3.

Fig. 14 is a modification of the arrangement shown in Fig. 13 but in which a cross-piece is provided instead of a T-piece. As previously, rosin emulsion is supplied along pipe section 2 and alum solution along pipe section 3. Water is supplied along the additional pipe section referenced as 4. The advantage of this arrangement is that when the flow of alum and size stops, the water from pipe section 4 keeps the line clear. Additionally the necessary minimum (Re) for turbulent flow can be achieved by adjusting the water flow. Furthermore the concentration of the alum/size mixture passing to the stock line may be adjusted.

It is also possible to use other commercial mixing devices other than the simple pipe arrangements shown in Figs. 3-14, but such other devices may be more expensive.

APPENDIX a

CONDITIONS GOVERNING THE TRANSITION FROM LAMINAR TO TURBULENT FLOW

The parameter used to assess, in a particular case, the flow regime for a fluid flow in a cylindrical pipe or annulus is known as Reynolds' Number, (Re). This can be considered as a dimensionless group of parameters defined by:-

$$(Re) = dVL/n \quad (1)$$

where

d = density of the fluid, which in SI has the units kg m^{-3}

V = flow velocity (average), m s^{-1}

L = characteristic length, m

n = viscosity, $\text{kg m}^{-1} \text{s}^{-1}$.

Therefore

$$(Re) = \frac{\text{kg m}^{-3} \cdot \text{m s}^{-1} \cdot \text{m}}{\text{kg m}^{-1} \text{s}^{-1}}$$

which is unitless.

There are problems over the definition of the 'characteristic length' in particular cases. For a cylindrical pipe many texts suggest that the radius be employed for flow in a cylindrical pipe [1]. However a standard work on fluid flow recommends the use of diameters, for example in the case of an annulus [2]. This choice will obviously make a difference in value of (Re) defining the transition point from laminar to turbulent flow, the different choices making a difference of 2x in the appropriate value.

Reference [1] suggests turbulent flow occurs when (Re) is greater than 1000, or 2000 if the diameter is used for the characteristic length. There has also been suggested that there should be considered to be a transitional region above this value, with true turbulence only being guaranteed when (Re) is greater than 2000 (based on L = radius).

When considering the effects of pipe radius changes in a practical plant situation, then the linear average flow velocity is not normally constant, usually it is the volume flow velocity, v, that is kept constant. These two velocities are related, for a cylindrical pipe, by:-

$$v = \pi r^2 V \quad (2)$$

which on substitution in (1) gives:-

$$(Re) = dV L / (\pi r^2 n) \quad (3)$$

Thus considering equations (1) and (3), then:-

(a) if V (the linear flow velocity) is constant then increasing the radius of the pipe increases (Re) and increases the chance of turbulence, but

(b) if v (the volume flow velocity) is constant then increasing the size of the pipe decreases the value of (Re) and decreases the chance of turbulence.

The relevance of this for the T-piece mixer is obvious, since volume flow rates are fixed, and therefore constrictions

in the mixing zone increase the value of (Re), the probability of turbulence and efficient rapid mixing.

The other factors that should be remembered are that these critical values of (Re) are for a long, smooth bore, cylindrical pipe. Irregularities in the walls and dirt in the pipe are likely to decrease the critical value of (Re). Thus for (Re) values greater than 2000 turbulence is virtually guaranteed, but considerably lower values of (Re) than 100 (say about 500) might be necessary to confidently predict laminar flow.

REFERENCES

[1] "Physics", SGStarling & AJWoodall; Longmans, Green & Co. (1950) p. 96.

[2] "Internal Fluid Flow", AJWard-Smith, Clarendon Press (1980) p. 174.

APPENDIX b

DESIGN FOR T-PIECE FOR MIXING EMULSION & ALUM BEFORE INJECTION

The following flow rates are assumed:-

1. Size emulsion flow = 150 - 400 l h⁻¹

2. Liquid Alum flow = 150 - 370 l h⁻¹

and that this is injected into a backwater stream flowing at a rate in excess of 600 l h⁻¹.

The Reynold's Number (Re) of the flow is given by:-

$$(Re) = dVL_n$$

where

d = density, V = flow velocity, n = viscosity, and

L = characteristic length (eg. the tube diameter)

If we work in SI units, then taking the solutions to have a viscosity slightly higher than water, we have n = 1 centipoise = 0.001 N s m⁻¹. The density is about 1 g cm⁻³ = 1000 kg m⁻³, and if we assume the internal diameter of the pipe to be 0.5 in = 0.0125 m then L = 0.0125 m. The total minimum flow is 300 l h⁻¹ = 300 x 10⁻³ m³ h⁻¹, hence:-

$$\begin{aligned} v &= 300 \times 10^{-3} / (60 \times 60) \text{ m}^3 \text{ s}^{-1} \\ &= 300 \times 10^{-3} \times 4 / (60 \times 60 \times \pi \times 0.0125^2) = \\ &0.068 \text{ m s}^{-1} \end{aligned}$$

in the 0.5 in diameter stainless pipe. Therefore:-

$$(Re) = (1000 \times 0.68 \times 0.0125) / 0.001 = 8500$$

which is considerably above the transition region limit of 2000 and well into the turbulent flow region. This means that the flow would also be turbulent even in the approaches to the combination of the flows in the mixing zone of the t-piece, where (Re) = 4250.

Claims

1. A method of sizing fibres in an aqueous suspension thereof, the method comprising:

- providing an aqueous suspension of fibres having a pH of at least 6,
- passing the aqueous suspension of fibres through a stock pipe (1),
- impinging upon each other turbulent, discrete streams of an aluminium salt solution (C) and a rosin emulsion (B) to effect mixing of the streams and provide a freshly prepared mixture of the aluminium salt and the rosin emulsion which is at an acidic pH less than that of the suspension of step a,
- providing the freshly prepared mixture in the fibre suspension at a substantially central region of the stock pipe to form a localised zone (D) of the freshly prepared mixture, and
- causing the freshly prepared mixture to be dispersed within the suspension whereby the mixture undergoes

a pH transition which is effective to cause rosin to be deposited on the fibres.

2. A method as claimed in claim 1 wherein the pH of the fibres suspension after dispersion of the rosin emulsion/ aluminium salt therein is at least 6.5.
3. A method as claimed in claim 2 wherein the pH of the fibre suspension after dispersion of the rosin emulsion/ aluminium salt therein is at least 6.7.
4. A method as claimed in any one of claims 1 to 3 wherein the pH of a mixture of the aluminium salt/rosin emulsion is less than 4.
5. A method as claimed in claim 4 wherein the pH of the mixture of the aluminium salt/rosin emulsion is about 3.8.
6. A method as claimed in any one of claims 1 to 5 wherein the aluminium salt is alum.
7. A method as claimed in claim 6 wherein the amount of alum used is such as to provide 1-4% by weight of alum dry basis on the fibres.
8. A method as claimed in claim 1 or 2, wherein the aluminium salt is a polyhydroxy aluminium salt.
9. A method as claimed in any one of claims 1 to 8 wherein the rosin emulsion comprises 20-50% by weight solids.
10. A method as claimed in any one of claims 1 to 9 wherein the rosin emulsion is used in an amount such as to provide 0.1-2% by weight (dry basis) on the fibres.
11. A method as claimed in any one of claims 1 to 10 wherein the fibres are cellulose fibres.
12. A method as claimed in any one of claims 1 to 11 wherein the fibrous suspension in which the localised zone of the mixture of aluminium salt solution and rosin emulsion is formed comprises 0.2 to 5% by weight of fibres.
13. Papermaking apparatus comprising suspension preparation means (100) for preparing a suspension of fibres, a foraminous wire (103) on which the suspension is deposited for preparing the paper, and a stock pipe (1) for conveying the suspension between the suspension preparation means and the wire wherein provided along the stock pipe is a mixing assembly having two inlets (2,3) into which separate streams of a rosin emulsion and an aluminium salt solution to be mixed can be supplied and having an outlet region located substantially centrally within the stock pipe (1) at which the localised zone of a mixture of the additives is provided.
14. Apparatus as claimed in claim 13 wherein the mixing assembly comprises two colinear conduits (2,3) along which the streams to be mixed can be supplied in opposite direction, and the outlet is at right angles to said conduit.
15. Apparatus as claimed in claim 14 wherein the mixing assembly is a T-piece.

Patentansprüche

1. Verfahren zum Leimen von Fasern in einer wäßrigen Suspension davon, wobei das Verfahren folgendes umfaßt:
 - a. Bereitstellen einer wäßrigen Fasersuspension mit einem pH von mindestens 6,
 - b. Durchlaufen lassen der wäßrigen Fasersuspension durch ein Stoffrohr (1),
 - c. Aufeinander Auftreffen lassen turbulenter, diskreter Ströme einer Aluminiumsalzlösung (C) und einer Harzemulsion (B), um ein Mischen der Ströme zu bewirken und ein frisch hergestelltes Gemisch aus dem Aluminiumsalz und der Harzemulsion bereitzustellen, das einen sauren pH aufweist, der unter dem der Suspension von Schritt a liegt,
 - d. Bereitstellen des frisch hergestellten Gemisches in der Fasersuspension in einem im wesentlichen zentralen Bereich des Stoffrohres zum Bilden einer lokalisierten zone (D) des frisch hergestellten Gemisches, und

e. Veranlassen, daß das frisch hergestellte Gemisch in der Suspension dispergiert wird, wobei das Gemisch einem pH-Übergang unterliegt, der die Ablagerung von Harz auf den Fasern bewirkt.

2. Verfahren nach Anspruch 1, bei dem der pH der Fasersuspension nach Dispersion der Harzemulsion/des Aluminiumsalzes darin mindestens 6,5 ist.
3. Verfahren nach Anspruch 2, bei dem der pH der Fasersuspension nach Dispersion der Harzemulsion/des Aluminiumsalzes darin mindestens 6,7 ist.
4. Verfahren nach einem der Ansprüche 1 bis 3, bei dem der pH eines Gemisches aus dem Aluminiumsalz/der Harzemulsion weniger als 4 ist.
5. Verfahren nach Anspruch 4, bei dem der pH des Gemisches aus dem Aluminiumsalz/der Harzemulsion ungefähr 3,8 ist.
6. Verfahren nach einem der Ansprüche 1 bis 5, bei dem das Aluminiumsalz technisches Aluminiumsulfat ist.
7. Verfahren nach Anspruch 6, bei dem die verwendete Menge von technischem Aluminiumsulfat dergestalt ist, um 1-4 Gew.-% technisches Aluminiumsulfat (Trockenmasse) bezogen auf die Fasern bereitzustellen.
8. Verfahren nach Anspruch 1 oder 2, bei dem das Aluminiumsalz ein Polyhydroxyaluminiumsalz ist.
9. Verfahren nach einem der Ansprüche 1 bis 8, bei dem die Harzemulsion aus 20-50 Gew.-% Trockensubstanz besteht.
10. Verfahren nach einem der Ansprüche 1 bis 9, bei dem die Harzemulsion in so einer Menge verwendet wird, daß 0,1-2 Gew.-% (Trockenmasse) bezogen auf die Fasern bereitgestellt wird.
11. Verfahren nach einem der Ansprüche 1 bis 10, bei dem die Fasern Cellulosefasern sind.
12. Verfahren nach einem der Ansprüche 1 bis 11, bei dem die Fasersuspension, in der die lokalisierte zone des Gemisches aus Aluminiumsalzlösung und Harzemulsion gebildet wird, aus 0,2 bis 5 Gew.-% Fasern besteht.
13. Papierherstellungsvorrichtung, welche folgendes umfaßt: Suspensionsherstellungsmittel (100) zum Herstellen einer Fasersuspension, ein Lochsieb (103), auf dem die suspension zur Herstellung des Papiers abgelagert wird und ein Stoffrohr (1) zum Befördern der Suspension zwischen dem suspensionsherstellungsmittel und dem Sieb, bei der entlang dem Stoffrohr ein Mischaggregat mit zwei Einlaufstutzen (2,3), in welche zu mischende gesonderte Ströme einer Harzemulsion bzw. einer Aluminiumsalzlösung gespeist werden können, und mit einem Auslaufbereich vorgesehen ist, der sich im wesentlichen zentral in dem Stoffrohr (1) befindet, an dem die lokalisierte Zone eines Gemisches der Additive vorgesehen ist.
14. Vorrichtung nach Anspruch 13, bei der das Mischaggregat zwei kollineare Rohrleitungen (2,3) enthält, entlang denen die zu mischenden ströme in entgegengesetzter Richtung eingespeist werden können, und der Auslaufstutzen sich rechtwinklig zu genannter Rohrleitung befindet.
15. Vorrichtung nach Anspruch 14, bei der das Mischaggregat ein T-stück ist.

Revendications

1. Méthode de collage de fibres dans une suspension aqueuse de celles-ci, la méthode comprenant:
 - a. la mise à disposition d'une suspension aqueuse de fibres ayant un pH d'au moins 6,
 - b. le passage de la suspension aqueuse de fibres à travers un tuyau de charge (1),
 - c. l'injection les uns sur les autres de courants turbulents discrets d'une solution de sel d'aluminium (C) et d'une émulsion de résine de pin (B), pour effectuer le mélange des courants et pour fournir un mélange fraî-

chement préparé du sel d'aluminium et de l'émulsion de résine de pin qui est à un pH acide inférieur à celui de la suspension de l'étape a,

d. la mise à disposition du mélange fraîchement préparé dans la suspension de fibres dans une région sensiblement centrale du tuyau de charge pour former une zone localisée (D) du mélange fraîchement préparé, et

e. provoquer la dispersion du mélange fraîchement préparé au sein de la suspension, le mélange subissant une transition de pH qui est efficace en vue de provoquer le dépôt de la résine de pin sur les fibres.

2. Méthode selon la revendication 1, dans laquelle le pH de la suspension des fibres après la dispersion de l'émulsion de résine de pin/du sel d'aluminium en son sein est d'au moins 6,5.

3. Méthode selon la revendication 2, dans laquelle le pH de la suspension de fibres après la dispersion de l'émulsion de résine de pin/du sel d'aluminium en son sein est d'au moins 6,7.

4. Méthode selon l'une quelconque des revendications 1 à 3, dans laquelle le pH d'un mélange du sel d'aluminium/ de l'émulsion de résine de pin est de moins de 4.

5. Méthode selon la revendication 4, dans laquelle le pH du mélange du sel d'aluminium/de l'émulsion de résine de pin est d'environ 3,8.

6. Méthode selon l'une quelconque des revendications 1 à 5, dans laquelle le sel d'aluminium est l'alun.

7. Méthode selon la revendication 6, dans laquelle la quantité d'alun utilisée est telle qu'elle fournisse 1-4 % en poids d'alun à base sèche sur les fibres.

8. Méthode selon la revendication 1 ou 2, dans laquelle le sel d'aluminium est un sel poiyhydroxylé d'aluminium.

9. Méthode selon l'une quelconque des revendications 1 à 8, dans laquelle l'émulsion de résine de pin comprend 20-50 % en poids de solides.

10. Méthode selon l'une quelconque des revendications 1 à 9, dans laquelle l'émulsion de résine de pin est utilisée dans une quantité telle qu'elle fournisse 0,1-2 % en poids (base sèche) sur les fibres.

11. Méthode selon l'une quelconque des revendications 1 à 10, dans laquelle les fibres sont des fibres de cellulose.

12. Méthode selon l'une quelconque des revendications 1 à 11, dans laquelle la suspension fibreuse, dans laquelle est formée la zone localisée du mélange de solution de sel d'aluminium et d'émulsion de résine de pin, comprend de 0,2 à 5 % en poids de fibres.

13. Appareil de fabrication de papier comprenant des moyens (100) de préparation de suspension pour la préparation d'une suspension de fibres, une toile foraminée (103) sur laquelle la suspension est déposée pour préparer le papier, et un tuyau de charge (1) pour l'acheminement de la suspension entre les moyens de préparation de suspension et la toile, dans lequel l'on prévoit, le long du tuyau de charge, un assemblage de mélange ayant deux entrées (2, 3), dans lesquelles on peut alimenter des courants séparés d'une émulsion de résine de pin et d'une solution de sel d'aluminium à des fins de mélange, et ayant une région de sortie située sensiblement de manière centrale au sein du tuyau de charge (1), où est prévue la zone localisée d'un mélange des additifs.

14. Appareil selon la revendication 13, dans lequel l'assemblage de mélange comprend deux conduits colinéaires (2, 3) le long desquels l'on peut fournir, en direction opposée, les courants qui sont à mélanger, et la sortie est à angle droit dudit conduit.

15. Appareil selon la revendication 14, dans lequel l'assemblage de mélange est une pièce en forme de T.

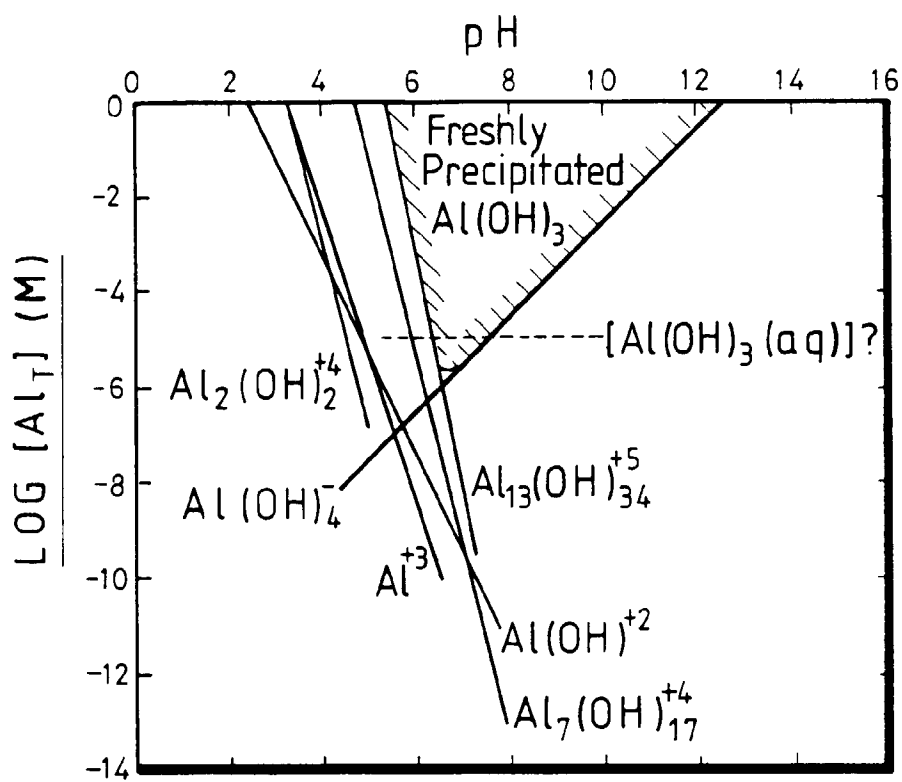


FIG. 1

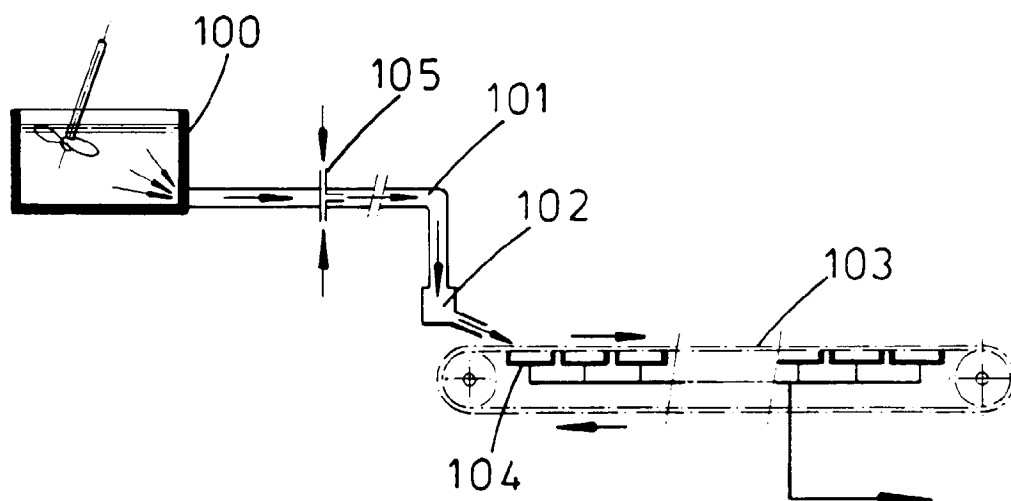


FIG. 2

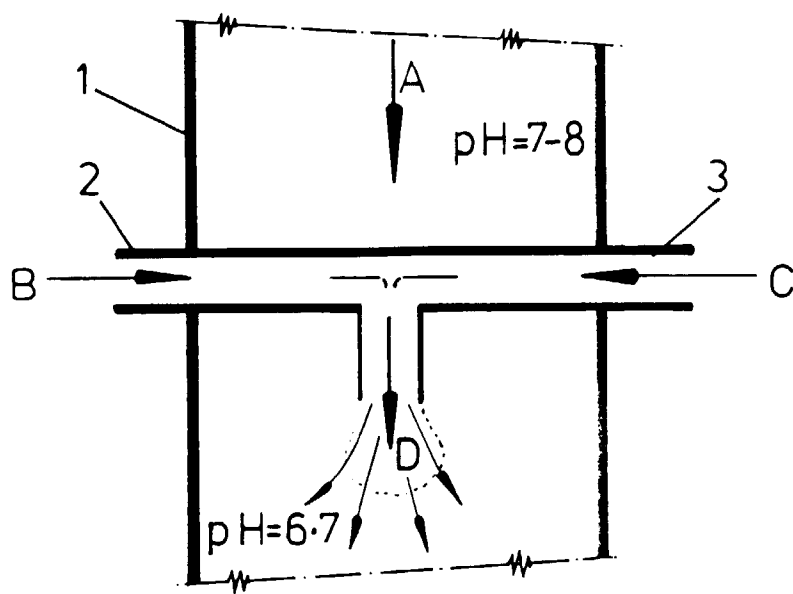


FIG. 3

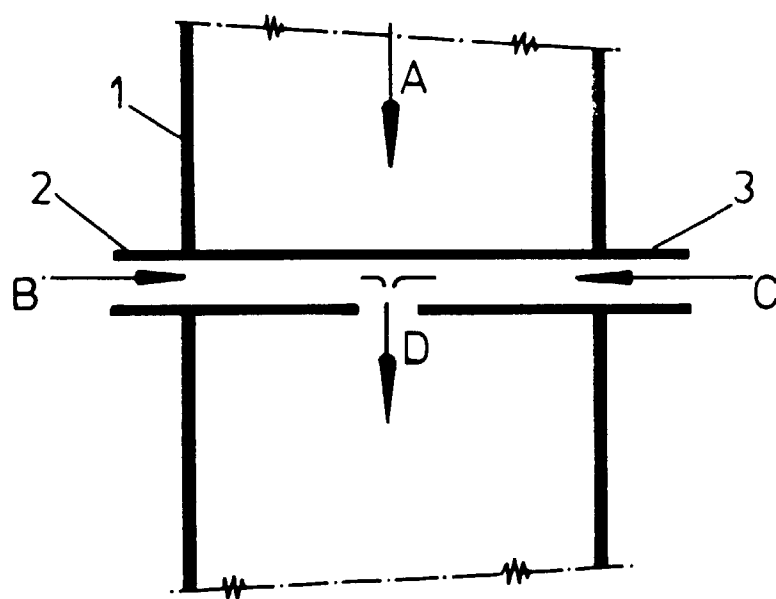


FIG. 4

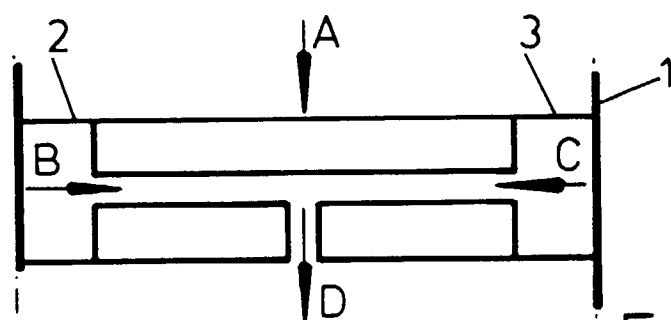


FIG. 5

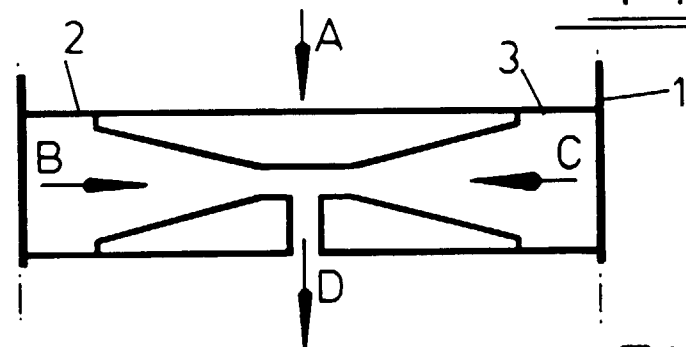


FIG. 6

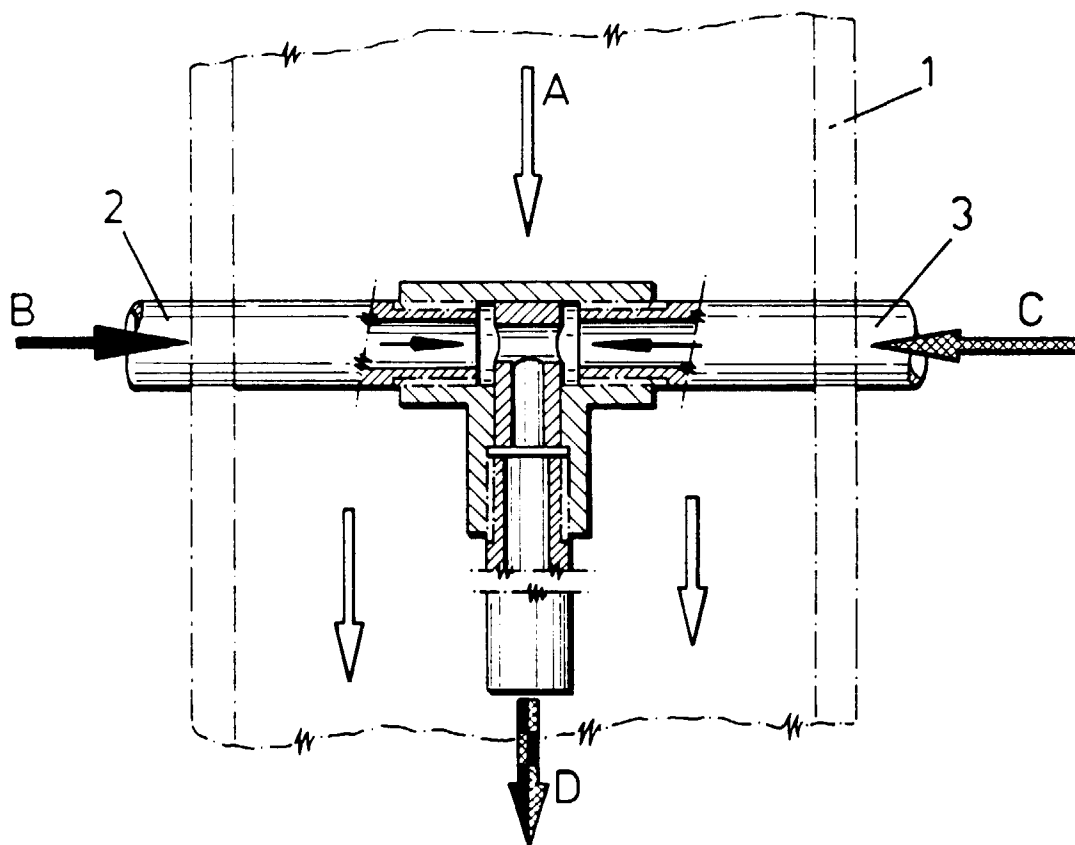


FIG. 7

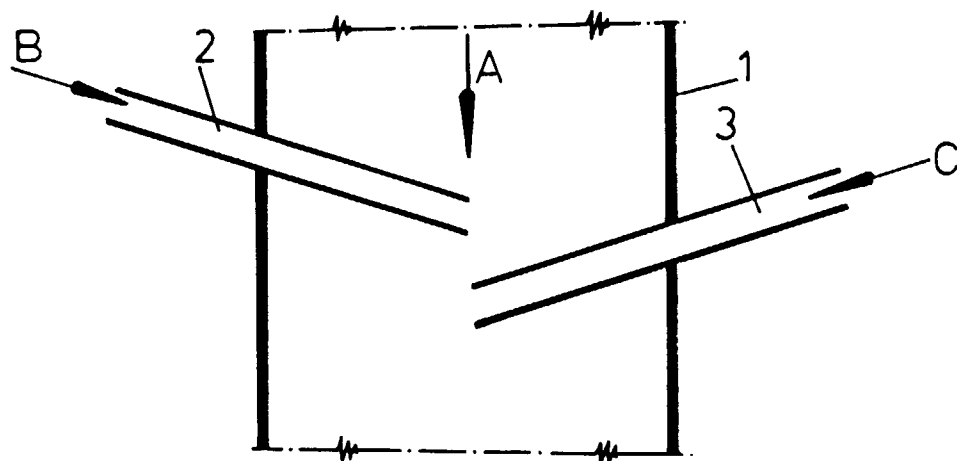


FIG. 8

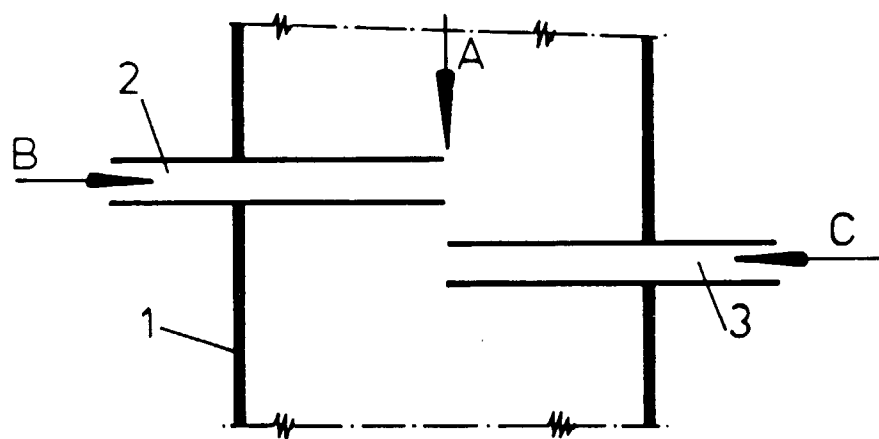
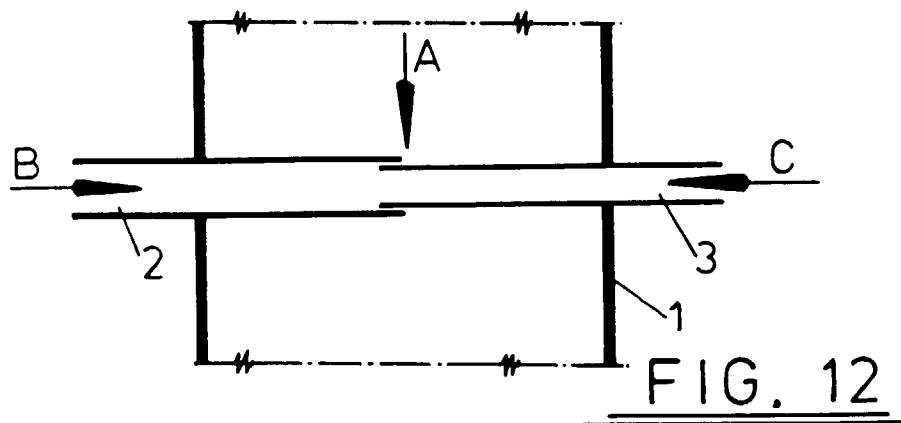
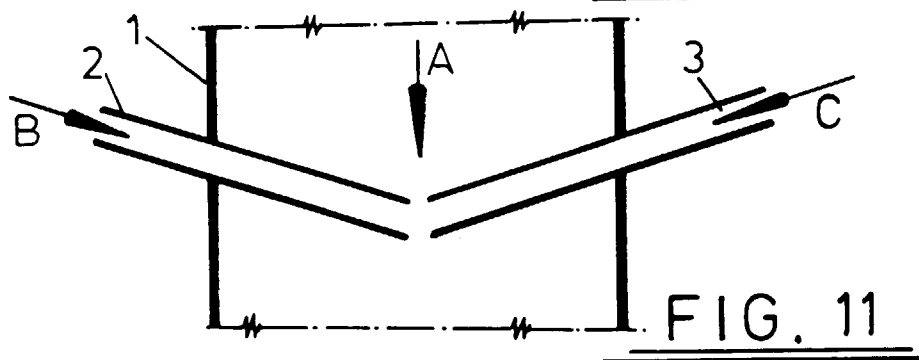
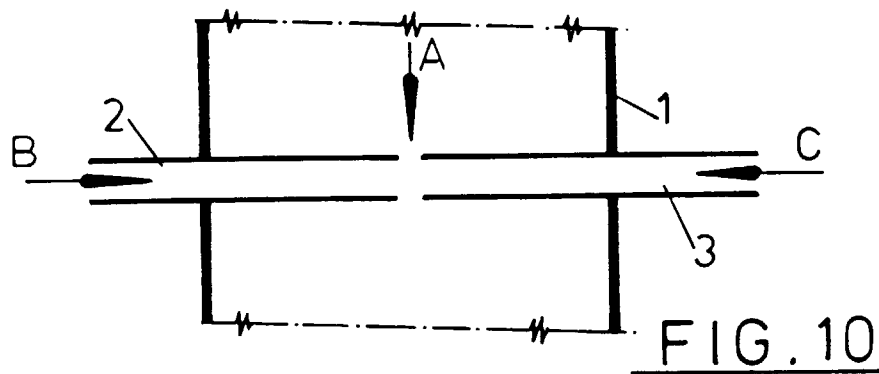


FIG. 9



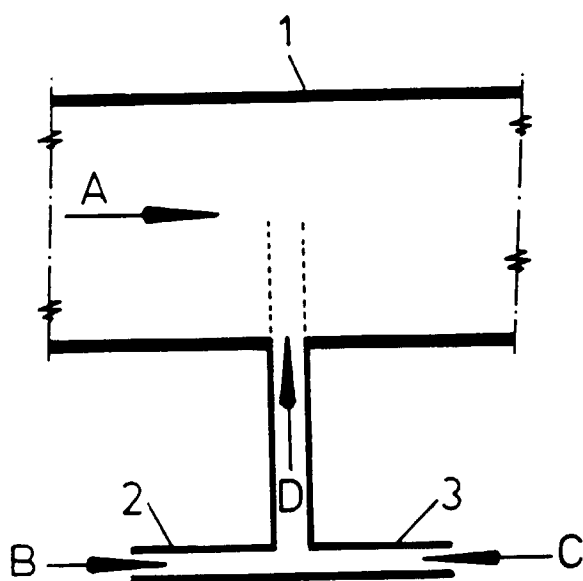


FIG. 13

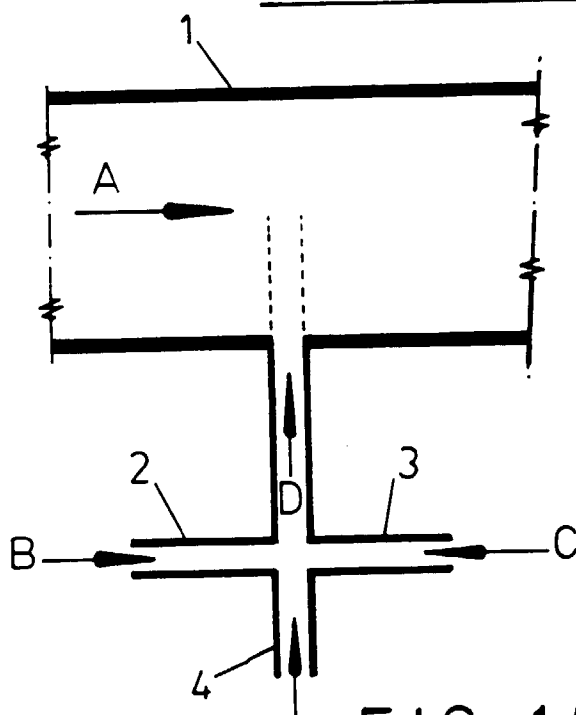


FIG. 14