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(71) Applicant: **Appliances Components Companies S.p.A.**
33170 Pordenone (IT)

(72) Inventors:
- **Sandron, Fabrizio**
  30025, Fossalta di Portogruaro (Venezia) (IT)
- **Bonacina, Sergio**
  22043, Galbiate (Lecco) (IT)

(74) Representative: **Gonella, Mario**
PROPRIA S.r.l.
P.O. Box 365
Via della Colonna, 35
33170 Pordenone (IT)

(54) Improvement in the pumping chamber of a centrifugal turbine pump

(57) Centrifugal turbine pump comprising an intake conduit, a delivery conduit, a pumping chamber, an impeller housed in the pumping chamber and provided with a plurality of vanes, wherein the intake conduit is coupled to the pumping chamber via a slightly conical flaring at the inlet-side section of said intake conduit into the pumping chamber. Preferably, the edge of said impeller facing the intake conduit comprises a corner-shaped section, wherein said corner projects into the inlet-side section of said intake conduit.

Alternatively, the site at which said pumping chamber couples to the inlet-side section of the intake conduit is provided in the form of two contiguous pleats resembling the bellows of an accordion, which define an annular accommodation in which there are rotatably accommodated said corner-shaped portions of respective ones of the vanes of said impeller.

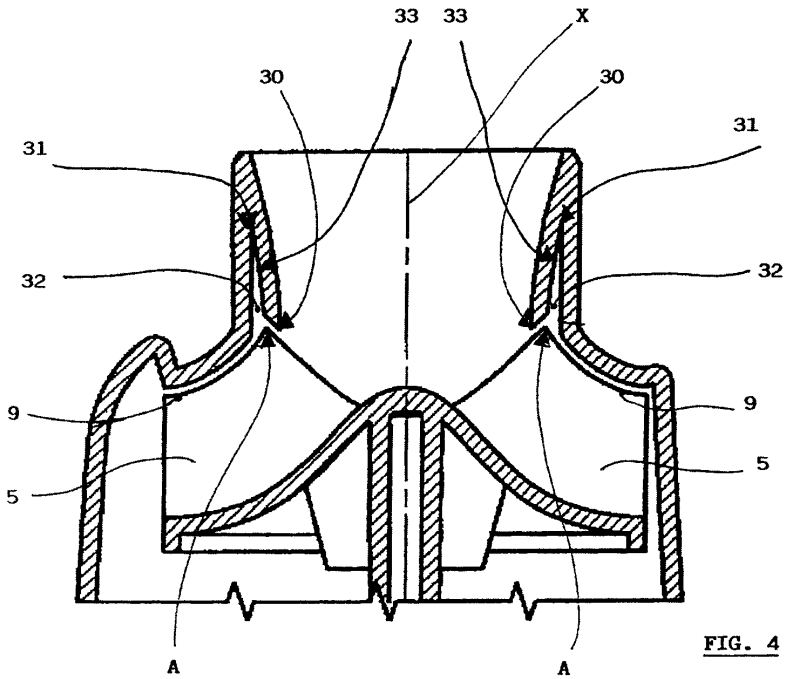

FIG. 4

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Description

[0001] The present invention relates to an improved kind of centrifugal turbine pump, preferably of the type generally used in connection with electrical home appliances, such as clothes washing machines, dishwashers, and the like, and provided therefore with such design and operating specifications as generally required in view of such applications. In particular, the present invention relates to the pumping chamber and the rotating vanes of the impeller of such pumps.

[0002] Since pumps of the above-cited kind are generally used in appliances and machines that are required to be very competitive as far as both costs and energy efficiency are concerned, a considerable, constant effort is most obviously being made in industry by manufacturing and design engineers in an attempt to continuously improve the overall operating and construction characteristics of such pumps.

[0003] The efforts of manufacturing and design engineers are in particular focussing on the possibility of providing impellers and pumping chambers that are effective in bringing in sensible improvements in the overall efficiency, so as to achieve a natural reduction in the size and the power rating of the motor used to drive said impeller.

[0004] What is obtained in this way, actually, is therefore a twofold advantage in terms of an improved water-handling, i.e. hydraulic efficiency and a resulting reduction in the size - and therefore the costs - of the motor used to drive the pump.

[0005] The shape of a pumping chamber and a related impeller of a centrifugal turbine pump - known also as regenerative pump in the art - are largely known to generally be of the type illustrated in Figure 2 of the US patent publication no. 4,869,642, as well as in the US patent publication no. 5,601,418.

[0006] In both such publications, there can be noticed that the gap between the body of the pumping chamber - on the side of the intake conduit - and the corresponding edges of the vanes has a rather considerable width, so that a vortex is able to form thereinside, which does not take part in, i.e. contribute to the pumping action, but uses anyway energy and, therefore, contributes to a deterioration of the overall efficiency of the pump; in addition, the presence of the core part of the pump, which is provided to act as a hub, and which is however situated exactly in front of the outflow port of the intake conduit, turns out as acting almost as a "plug" that partially obstructs the inflow of the liquor into the pumping chamber.

[0007] No practical solutions are currently known to effectively counter the second one of the above-noted drawbacks, since the presence of vanes having as great a height as possible obviously implies that even the core portion, i.e. the hub thereof cannot but be situated in a position that at best comes close to be in front of the inflow port of the intake conduit.

[0008] As far as the first one of the above-cited drawbacks is concerned, no possibility is given for the width of said gap to be reduced beyond a certain limit, since the construction and the assembly of the pumping chamber are done and carried out using substantially industrial technologies and, therefore, under standard tolerances that cannot be reduced beyond a certain extent, either, owing basically to the shrinkage effect of moulded plastics, i.e. the material which both the impeller and the pumping chamber are generally made of.

[0009] It would therefore be desirable, and it is the main object of the present invention, actually, to provide a kind of centrifugal water turbine pump that is effective in doing away with the two above-indicated drawbacks of prior-art pumps of the same kind, so as to ensure a high water-handling, i.e. hydraulic efficiency jointly with a pumping chamber having a reduced size.

[0010] Within this general object, it is a purpose of the present invention to provide a pump of the above-indicated kind, which is capable of being manufactured using readily available techniques and machinery at fully competitive costs.

[0011] According to the present invention, these aims are reached in a centrifugal turbine pump incorporating the features as defined and recited in the appended claims.

[0012] Features and advantages of the present invention will anyway be more readily understood from the description that is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a median cross-sectional view through the axis of rotation of the impeller, the pumping chamber and the intake conduit of a pump according to the present invention in a first embodiment thereof;
- Figure 2 is a planar view of the image of a rotating vane when figuratively lying on a plane passing through the axis of rotation of the impeller;
- Figure 3 is a median cross-sectional view through the axis of rotation of the impeller, the pumping chamber and the intake conduit of a pump according to the present invention in a second embodiment thereof;
- Figure 4 is a median cross-sectional view through the axis of rotation of the impeller, the pumping chamber and the intake conduit of a pump according to the present invention in a third embodiment thereof;
- Figure 5 is a diagrammatical view of a graph plotting the trend, i.e. variation of the hydraulic efficiency of an inventive pump, as compared with the hydraulic efficiency of a similar prior-art pump, versus the flow rate thereof, when said pump is not provided with the inventive contrivance (curve R), when the pump

is on the contrary provided with the inventive contrivance according to the first embodiment thereof illustrated in Figure 1 (curve A), and when the pump is on the contrary provided with the inventive contrivance according to the second embodiment thereof illustrated in Figure 3 (curve B).

[0013] With reference to Figure 1, there is illustrated a first embodiment of the invention, which comprises an intake conduit 1, a pumping chamber 3 and, housed thereinside, an impeller with related vanes 5.

[0014] The end portion 6 of said intake conduit is not cylindrical, as it usually occurs, but is slightly flaring upwards, i.e. narrowing conically towards the inflow end into the pumping chamber, as indicated at 16 in Figure 1. It has in fact been found that such slight reduction in the inflow section of the conduit into the pumping chamber, far from producing a reduction in the flow rate, is rather effective in improving the linearity of the flow lines of the liquor being let into the chamber, since a contraction in the cross-section of a conduit, through which there flows a fluid, generally tends to reduce the vorticity of the fluid flow and, as a result, also improves - albeit slightly - the flow rate.

[0015] Any - albeit limited - flow-rate reduction should be avoided, actually, even in consideration of further embodiments of the inventive pump that are based on taking advantage in a particularly effective manner of the above-described reduction in the cross-section area of the end portion 6 of the intake conduit.

[0016] With reference to Figure 2, which illustrates the contour of a vane 5 of the impeller lying on a plane passing through the axis X of the same impeller, the edge 10 of such vane that is disposed to face the zone where said intake conduit 1 couples to, i.e. flows into the pumping chamber 3, comprises in fact a portion 7 which is shaped so as to form a corner with an angle A that is substantially oriented in a direction towards said intake conduit, or preferentially towards the transition region 8 between said intake conduit and said pumping chamber.

[0017] If the latter is embodied as generally illustrated in Figure 3, i.e. with said transition region 8 in the form of a continuous curve following a substantially constant curvature radius, a combination of geometries, i.e. shapes and proportions among the various parts involved may be provided so that - relative to said angle A - the outer portion 9 of said edge 10 is capable of coming sensibly closer, and for quite appreciable a length, to the inner contour of said transition region 8.

[0018] It has been experimentally found that such contrivance is really effective in improving both the hydraulic efficiency and the discharge head of the turbine pump, since any vorticity that may possibly arise and come into existence between the vanes of said impeller and said transition region 8 would be minimized, or even eliminated, owing to the width of the gap existing between said two elements being very small, actually. The resulting improvement is best emphasized by the graph illustrated in Figure 5, which shall be discussed further on.

[0019] A further advantageous embodiment of the present invention is illustrated in Figure 4, wherein it can be noticed that the above-mentioned transition region - instead of being embodied in the form of a continuous curve following a substantially constant curvature radius - is given an "accordion-like" pleated contour with two opposite angles, so that the section passing through the axis X of the impeller shows a sawtooth-like profile, i.e. a profile resembling the teeth of a saw.

[0020] Such transition region has two opposite circular edges 30 and 31 extending concentrically with said axis X, wherein the edge 30 lying closer to the axis X is also the innermost edge relative to the pumping chamber and, as a result, the edge that lies also closer to the body of the respective impeller.

[0021] Therefore, an annular recessing portion 32 is formed between said two edges 30 and 31, which is delimited towards said axis X by the side 33 joining said two edges 30 and 31 with each other.

[0022] Those skilled in the art will be fully capable of appreciating that, although the present description refers to a three-dimensional construction, actually, use is however made of terms which are usually employed in connection with planar constructions, due practically to the sole reason that such is the construction appearing in Figure 4, which in fact refers to the corresponding planar section.

[0023] Going on with the description, now, said corner-shaped portion 7 featuring an angle A is appropriately sized and proportioned so that, when the impeller is duly assembled, such portion is able to fit into said annular recessing portion 32 and, preferably, said angle A is capable of fitting in a wedge-like manner into the innermost region of said annular recessing portion 32.

[0024] A still further improved embodiment of the present invention may be again be provided as follows: referring again to Figures 2 and 4, the inner side 11 of said edges 10 of the respective vanes is disposed so as to be substantially oriented towards the core portion of the impeller, i.e. in a direction inclining at an acute angle H relative to said axis X; the actual purpose of this improvement lies in the fact that any form whatsoever of resistance or hindrance to the movement of the inflow of fluid entering the pumping chamber is thereby effectively prevented from occurring, and therefore, if the core portion of the vanes is set back to some extent, the vanes themselves are effectively prevented from simply and just centrifuging the inflowing fluid, i.e. accelerating it by the sole centrifugal force, before delivering it to the outermost, i.e. side portions of the vanes for it to be propelled by turbine effect towards the delivery or discharge conduit.

[0025] It has in fact been found that - with the above-described improvement - the fluid is immediately transferred to the outermost region of the vanes, thereby saving it from being first "whirled" in the innermost, core region of the same vanes.

[0026] The improvements that are generally achieved with the present invention can most readily be inferred from the graphical representation in Figure 5, where the trend, i.e. variation of the hydraulic efficiency (i.e. energy efficiency) of an inventive pump is plotted, as compared with the hydraulic efficiency of a similar prior-art pump, versus the flow rate thereof, when said pump is not provided with the inventive contrivance (curve R), when the pump is on the contrary provided with the inventive contrivance according to the first embodiment thereof illustrated in Figure 1 (curve A), and when the pump is provided with the inventive contrivance according to the second embodiment thereof illustrated in Figure 3 (curve B).

[0027] In this connection, it should in particular be noticed that an appreciable improvement in the efficiency of the pump is shown by the curve A to mainly take place - as compared with the one shown by the curve R - when the pump is operated at rather low-to-medium flow rates, from approx. 60 to 80 l/min, whereas a most marked efficiency improvement is mainly obtained between the curve R and the curve B when the pump is operated at higher flow rates in excess of 80 l/min.

Claims

1. Centrifugal turbine pump comprising:

   - an intake conduit (1),
   - a pumping chamber (3),
   - an impeller (4) housed in said pumping chamber,
   - a plurality of vanes (5) arranged on and attached to said impeller,

   characterized in that said intake conduit joins to said pumping chamber (3) via a flared section (16) narrowing with a slightly conical configuration along the end portion (6) of said intake conduit flowing into said pumping chamber.

2. Centrifugal turbine pump according to claim 1, **characterized in that** the edge (10) of said vanes (5) facing said intake conduit comprises a corner-shaped portion (7) forming an angle (A).

3. Centrifugal turbine pump according to claim 2, **characterized in that** the portion of said edge (10) situated outside said angle (A) is provided to tightly conform to the contour of the transition region (8) from said intake conduit to said pumping chamber.

4. Centrifugal turbine pump according to claim 1 or 2, **characterized in that**:

   - said transition region (8) from said intake conduit (1) to said pumping chamber (3) is given an accordion-like pleated contour with two concentric circular edges (30, 31) bending in a mutually opposite direction, wherein the innermost circular edge (30) lies closer to the body of respective impeller than the outermost circular edge (31).
   - said accordion-like pleated transition region (8) forms an annular recess (32) that is substantially situated between said innermost circular edge (30) and said outermost circular edge (31).

5. Centrifugal turbine pump according to claim 4, **characterized in that** said portion (7) shaped into a corner-like configuration (A) of said edges (10) projects into said annular recess (32).

6. Centrifugal turbine pump according to any of the claims 2 to 5, **characterized in that** the inward side (11) of said portion (7) shaped into a corner-like configuration (A) of said vanes converges towards the core portion (20) of the impeller or, anyway, forms an acute angle (H) relative to the axis (X) oriented towards said intake conduit.

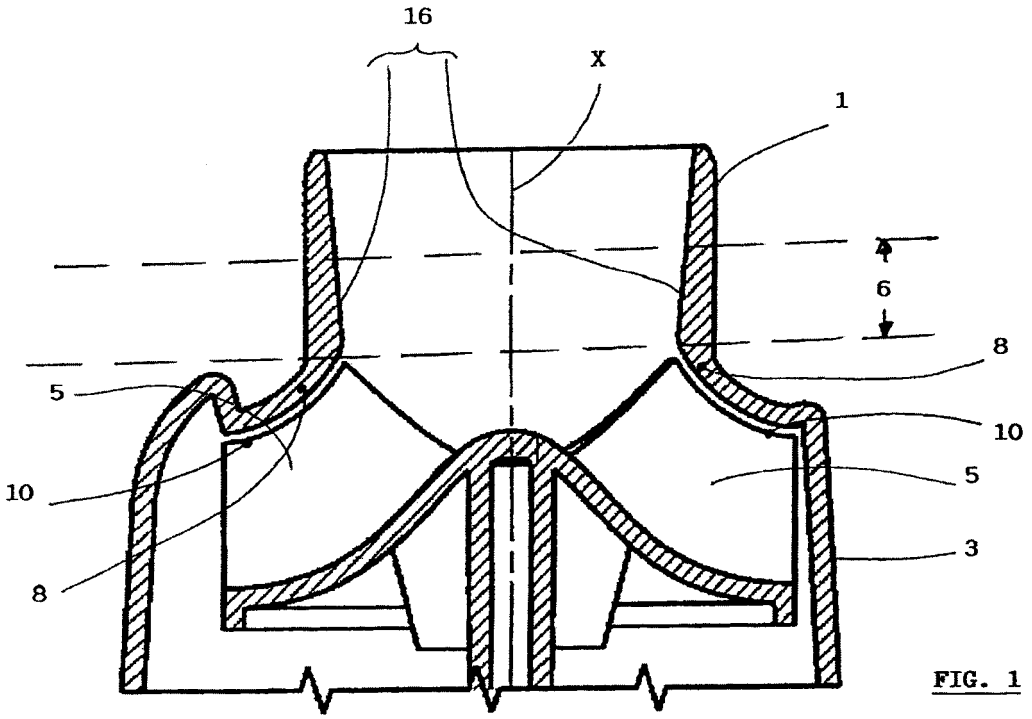

FIG. 1

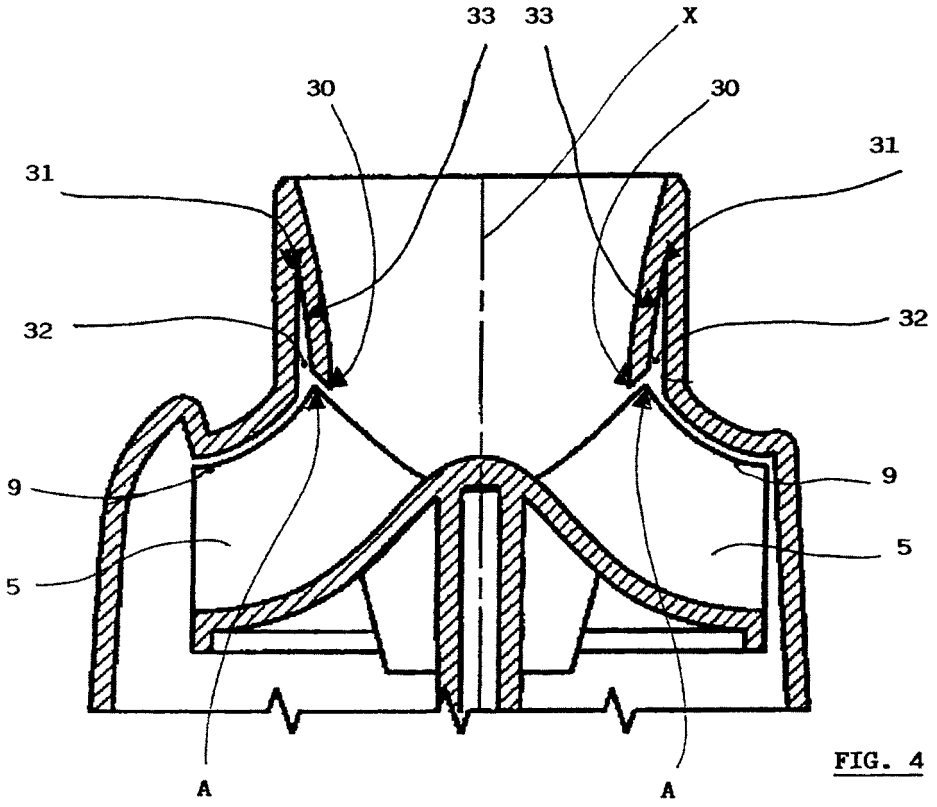

FIG. 4

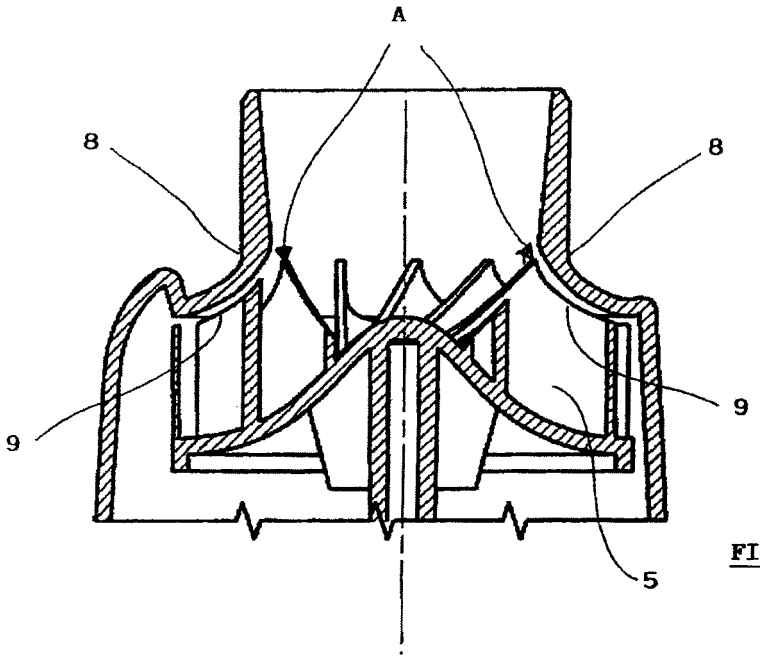

FIG. 3

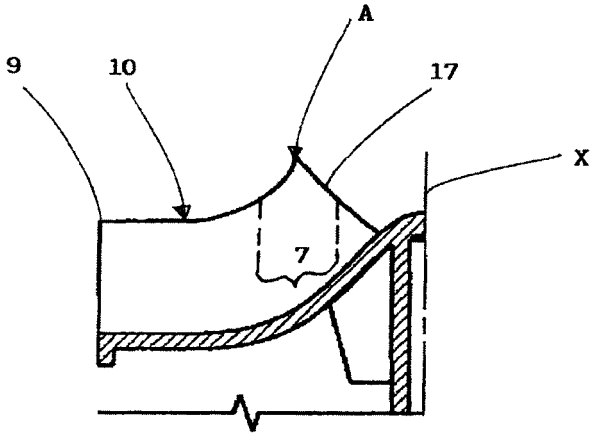

FIG. 2

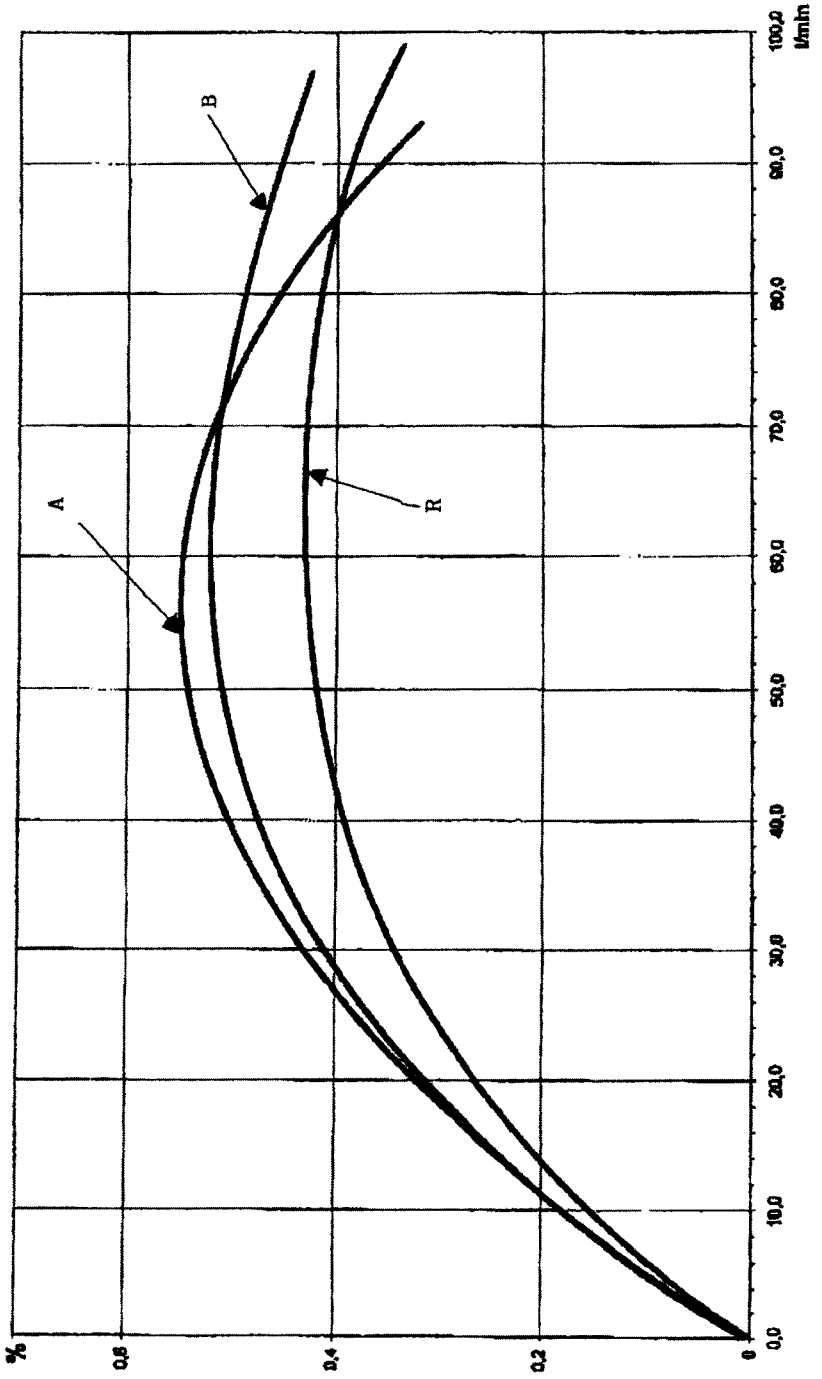

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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- US 5601418 A **[0005]**