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(54) **Measurement value generators for determining the through-flow rate of a flowing fluid**

(57) A measurement value generator for fluid flow has two connection nipples 14, 15 which are disposed on one axis, for installation in a pipe conduit. Two distribution chambers 1, 2 are separated from each other by a wall 3 and have a feed 7 and a discharge 8 respectively, through the connection nipples 14, 15. A pipe 4 connects the distribution chambers 1, 2 and penetrates thereinto at both ends. Disposed opposite the end faces of the pipe 4 are respective measuring transducers 9, 10. The transmission surfaces 11, 12 of the transducers 9, 10 apply ultrasonic pulses to a fluid flowing in the pipe 4 for the purposes of measuring transit time and determining the through-flow rate. The distribution chambers 1, 2 enclose the two end portions 5, 6 of the pipe 4 in a respective annular passage 16, 17 and can be in the form of square members or can be in the form of continuously enlarging pipe bends. The pipe 4 may be disposed perpendicularly or at any angle to the axis of the connection nipples 14, 15. It may also be bent in a U-shaped configuration; in that case, the measuring transducers 9, 10 are disposed one beside the other and can be covered by a common housing.

Fig. 3

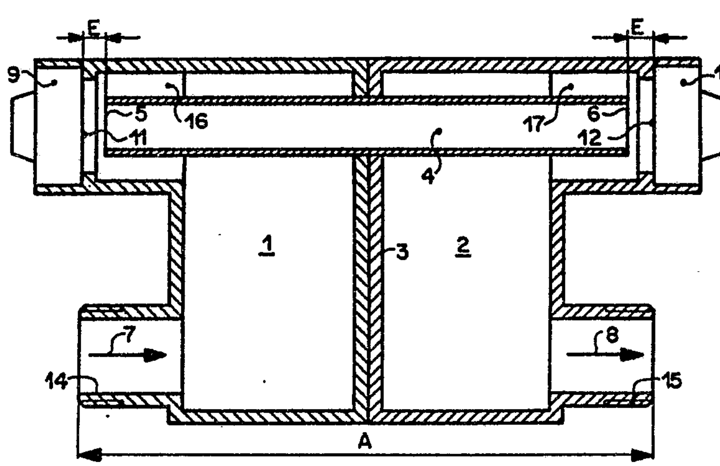

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Fig. 1

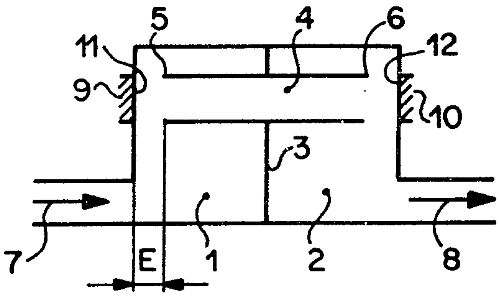

Fig. 2

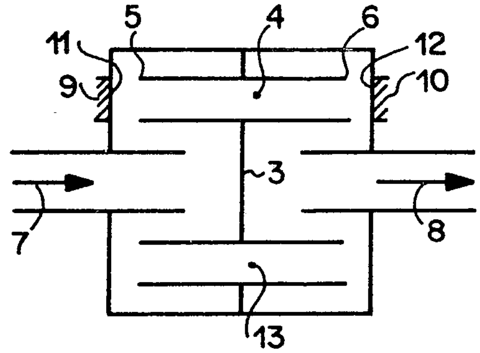

Fig. 3

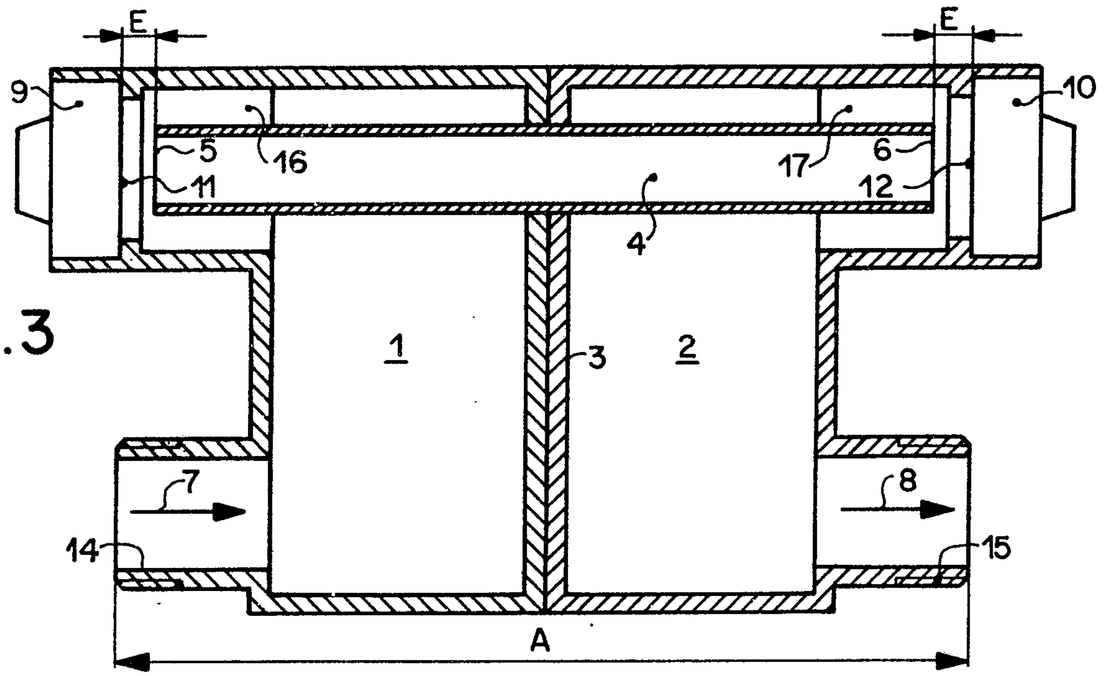

Fig. 4

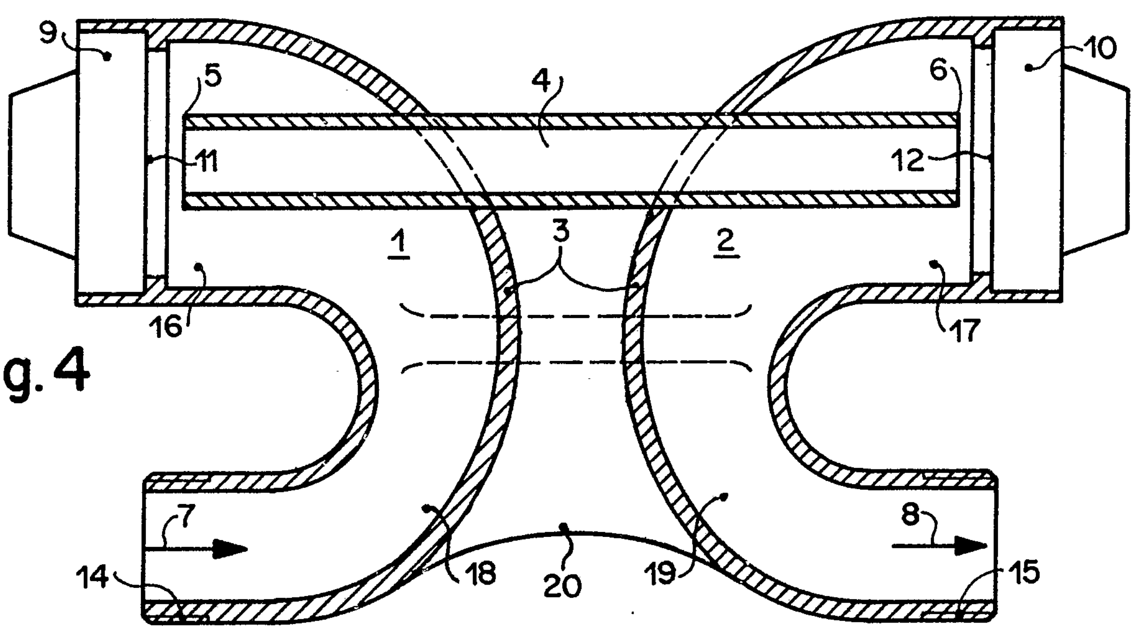

Fig. 5

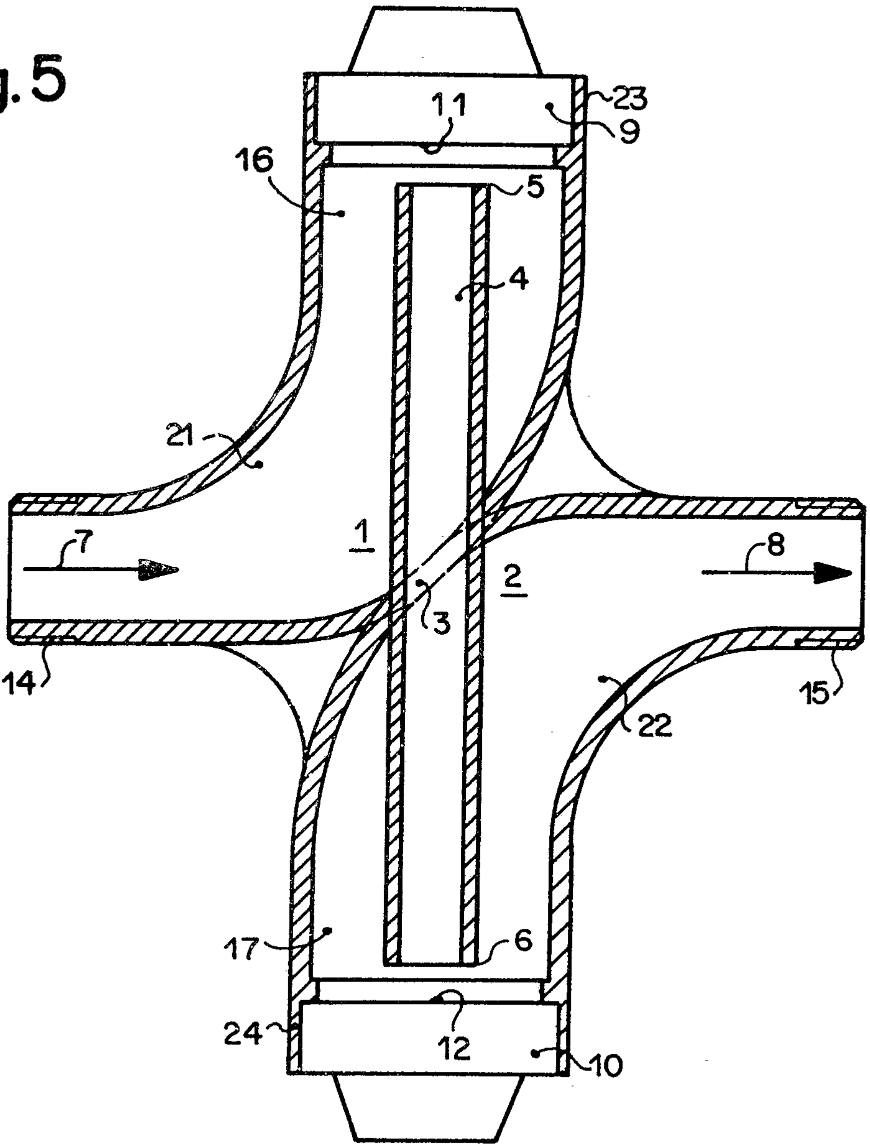
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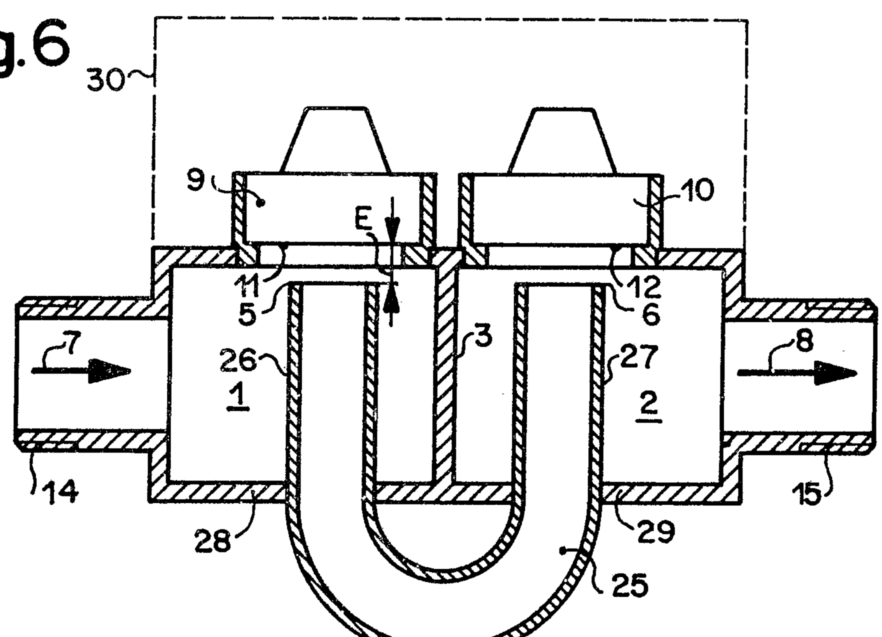
Fig. 6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SPECIFICATION

Measurement value generators for determining the through-flow rate of a flowing fluid

This invention relates to measurement value generators for determining the through-flow rate of a flowing fluid.

For the purposes of determining the amount of fluid flowing through a pipe system, it is known for the flowing fluid to be acted upon by ultrasonic pulses, in order to be able to arrive at the mean flow speed of the fluid and thus the fluid flow rate per unit of time, on the basis of the transit time of the pulses. In this respect, measuring the transit times of the pulses along a tube portion through which the fluid flows has been found to be the most expedient method. Such an arrangement is described in DOS No 23 39 631, but this arrangement also suffers from various disadvantages, in particular; when the measuring transducers are installed directly into the flow of fluid in the pipe system, the measuring transducers are not accessible from the outside, flow resistances occur, and the cost of the fluid-tight connection to the electrical terminals is high. When using two T-shaped members whose connections which are disposed on one axis are on one side connected by a straight pipe and on the other side are closed by a respective measuring transducer, the change in the direction of flow causes an excessive pressure drop to be produced directly at the measuring locations. In addition, the installation length is excessive.

With regard to installing through-flow meters in service water conduits, there are standards about the distance between the two ends of the conduit, between which the through-flow meter must be installed. The relatively small distances permit, in the state of the art, the installation of only very short and thus inaccurate sound measuring sections.

According to the present invention there is provided a measurement value generator for determining the through-flow rate of a fluid flowing through a pipe system, by measuring the transit times of ultrasound within the fluid and along a measuring section, the generator comprising:

a pipe providing said measuring section and through which the fluid flows;

relatively large-volume distribution chambers for a feed and a discharge of the fluid; and

respective measuring transducers arranged opposite the two ends of said measuring section in said distribution chamber and which are in direct contact with the fluid;

the axis of said measuring section forming a perpendicular line through the centres of the active transmission surfaces of said measuring transducers;

respective end portions of the pipe passing through the walls of said distribution chambers, and penetrating into the interiors of said distribution chambers to such distances that each said distribution chamber encloses the associated said end portion of the pipe on all sides at least over a length which is greater than the inside diameter of the pipe;

the cross-section of said distribution chambers through which cross-section the fluid is to flow, being a multiple of the inside cross-section of the pipe; and

said transmission surfaces of said measuring transducers being arranged at a spacing from the end faces of the pipe to leave open the required through-flow cross-section.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like references designate like elements, and in which:

Figures 1 and 2 each show a diagrammatic view of a measurement value generator; and

Figures 3 to 6 show respective sectional views through four measurement value generators of different designs.

Referring to the drawings, two large-volume distribution chambers 1 and 2 which form square hollow bodies are separated from each other by at least one wall 3. A pipe 4 which serves as a measuring section passes through the wall 3 and its end portions 5 and 6 penetrate into the interiors of the two chambers 1 and 2 to such an extent that each chamber 1 and 2 encloses the corresponding end portions 5 and 6 of the pipe 4 on all sides at least over a length which is greater than the inside diameter of the pipe 4.

The distribution chambers 1 and 2 have a feed 7 and a discharge 8 which are illustrated by a respective arrow in the drawings and which are arranged in the chambers 1 and 2 at positions remote from the end portions 5 and 6 of the pipe 4. The connections for the feed 7 and the discharge 8 are advantageously on a common axis. The fluid in respect of which a measurement is to be made flows from the feed 7 through the first chamber 1 and passes into the pipe 4 at the opening in the end portion 5, leaves the pipe 4 at the opening in the other end portion 6, flows through the second chamber 2 and arrives at the discharge 8. The axis of the pipe 4 forms a perpendicular line through the centres of transmission surfaces 11 and 12 of respective measuring transducers 9 and 10. The transmission surfaces 11 and 12 are directly exposed to the fluid and are each at a spacing E from the end surface of the end portions 5 and 6 respectively of the pipe 4. The distances E are so selected that, on the one hand, the fluid has two through-flow sections of maximum size at the end faces of the pipe 4. On the other hand, with regard to accuracy in measuring the transit times, it is desirable for the distance E to be kept as small as possible. Good results are obtained when the distances E are approximately half the inside diameter of the pipe 4.

Figure 2 diagrammatically shows how an increase in the measuring range of a measurement value generator can be obtained by dividing the total flow into two part flows. Symmetrical arrangement of the two part flows provides a separation action which is independent of through-flow. More than two part flows can also be produced. Besides the pipe 4 which forms the measuring section, there is also at least one further identical pipe 13 which interconnects the two chambers 1 and 2. For this purpose, each further pipe 13 is arranged in the same manner in space as the pipe 4, with regard to the magnitude of the distance E and the feed 7 and the discharge 8, in both chambers 1 and 2.

In the embodiment shown in Figure 3, the distribution chambers 1 and 2 comprise square hollow bodies, each having its own separating wall 3. The hollow bodies are fixedly connected together with their walls 3 abutting. A respective connection nipple or fitment 14 and 15 disposed in Figure 3 at the lower ends of the chambers 1 and 2 provide for the feed 7 and the discharge 8 respectively of the fluid. The distance A between the end faces of the two connection nipples 14 and 15 is 190 mm in the present embodiment, and corresponds to a standard distance for the installation of water meters.

In Figure 3, the pipe 4 is arranged in the vicinity of the upper edge of the distribution chambers 1 and 2. The pipe 4 passes through the two walls 3, being sealed at its peripheral surface. Between the connection nipples 14 and 15 and the pipe 4 there is thus a respective space through which the fluid must flow. The use of large-volume chambers 1 and 2 makes it possible for the space in the chambers 1 and 2, through which the fluid must flow, to be made many times greater in cross-section than the inside cross-section of the pipe 4. This causes the flow resistance in the chambers 1 and 2 to be low, which prevents eddy or swirl formation and thus pressure loss and cavitation phenomena, and ensures a uniform feed and discharge of the fluid, over the entire periphery of the end faces of the pipe 4.

So that the measuring section can be of the maximum possible length, in order to increase the degree of accuracy in the measuring operation, with a given distance A between the connection nipples 14 and 15, it is desirable for the distribution chambers 1 and 2 to be additionally extended as shown in Figure 3, in the ragion of the end portions 5 and 6 of the pipe 4, and in particular in such a way that the parts of the chambers 1 and 2 respectively which enclose the two end portions 5 and 6 of the pipe 4 each form respective annular passages 16 and 17 which are concentric with the axis of the pipe 4 and through which the fluid flows into the opening in one end portion 5 and out of the opening in the other end 6 respectively, in a direction opposite to the direction of flow in the pipe 4.

In the embodiment shown in Figure 4, the two chambers 1 and 2 comprise two 180° pipe bends 18 and 19 which extend from the two connection nipples 14 and 15 and which continuously increase in width and which merge into the two annular passages 16 and 17. The pipe 4 passes through the 180° pipe blends 18 and 19 which are held together in their relative positioning by at least one rib 20. At their enlarged ends, the pipe bends 18 and 19 carry the measuring transducers 9 and 10.

In the above-described embodiments, the measuring section is in the form of a pipe 4 whose axis is a straight line which is parallel to the axis formed by the two connection nipples 14 and 15. This provides a satisfactorily functional construction and a favourable arrangement for production, in which respect the housing forming the chambers 1 and 2 can be cast, pressed, in one or two parts, screwed or soldered. The pipe 4 advantageously comprises drawn material. The pipe 4 can be cast in place, pressed in, soldered or sealingly mounted in any other suitable manner.

When producing the device by casting, it is desirable for the pipe 4 to be treated on its inside surface, for example by machining, in order to reduce the flow resistance.

For the purposes of reducing flow losses due to the change in the direction of the flow of fluid, it is also possible to use arrangements in which the axis of the pipe 4, which is a straight line, is at any angle to the axis formed by the two connection nipples 14 and 15.

Figure 5 shows an embodiment in which the axes intersect at a point and form a right angle to each other.

This is achieved by the distribution chambers 1 and 2 comprising two 90° pipe bends 21 and 22 which extend from the two connection nipples 14 and 15 and which continuously increase in size, with enlarged ends 23 and 24 carrying the measuring transducers 9 and 10.

With the pipe bends 18 and 19 which serve as the distribution chambers 1 and 2 being of a suitable configuration, as shown in Figure 4, it is also possible to arrive at other alternative forms which are advantageous from the point of view of fluid flow. Thus, referring to Figure 4, the feed 7 which is at bottom left could be taken to the end portion 6 of the pipe 4 at top right, while the fluid issuing at the end portion 5 of the pipe 4 would be taken to the discharge 8.

The 180° change in direction of the pipe bends 18 and 19 in Figure 4 is then omitted, and for this purpose the pipe bends must be crossed somewhat in a direction normal to the plane of the drawing and the pipe 4 must be pivoted slightly with its axis in a plane normal to the plane of the drawing.

In the measurement value generator shown in Figure 6, the two distribution chambers 1 and 2 comprise two square hollow bodies with a common wall 3. A pipe 25 which forms the measuring section is bent into a U-shaped configuration, with the limb portions 26 and 27 thereof passing through respective side walls 28 and 29 of the chambers 1 and 2 respectively, and extending into a respective one of the chambers 1 and 2. The ends of the limb portions 26 and 27 are directed towards the measuring transducers 9 and 10 which are disposed at the oppositely located walls and are also mounted at a spacing E from the transmission surfaces 11 and 12 of the measuring transducers 9 and 10. In the present embodiment also, the size of the chambers 1 and 2 ensures the free feed and discharge respectively of the fluid at the end portions 5 and 6 of the pipe 4, along the entire periphery of the two limb portions 26 and 27 respectively. Such an arrangement has the advantage that the two measuring transducers 9 and 10 are disposed close together and can be covered by a common housing 30 which is shown by a broken line in Figure 6. The housing 30 also encloses the electronic circuit required for evaluation of the measurement values. There are no open-access electrical leads to the measuring transducers 9 and 10, and thus the possibility of fraudulent intervention is reduced.

The above-described measurement value generators are particularly suitable for use in a heat meter, for which purpose, besides the flow rate, the temperature difference between a feed and a return is also detected.

CLAIMS

1. A measurement value generator for determining the through-flow rate of a fluid flowing through a pipe system, by measuring the transit times of ultrasound within the fluid and along a measuring section, the generator comprising:

a pipe providing said measuring section and through which the fluid flows;

relatively large-volume distribution chambers for a feed and a discharge of the fluid; and

respective measuring transducers arranged opposite the two ends of said measuring section in said distribution chamber and which are in direct contact with the fluid;

the axis of said measuring section forming a perpendicular line through the centres of the active transmission surfaces of said measuring transducers;

respective end portions of the pipe passing through the walls of said distribution chambers, and penetrating into the interiors of said distribution chambers to such distances that each said distribution chamber encloses the associated said end portion of the pipe on all sides at least over a length which is greater than the inside diameter of the pipe;

the cross-section of said distribution chambers, through which cross-section the fluid is to flow, being a multiple of the inside cross-section of the pipe; and

said transmission surfaces of said measuring transducers being arranged at a spacing from the end faces of the pipe to leave open the required through-flow cross-section.

2. A generator according to claim 1 wherein said spacing is approximately half the inside diameter of the pipe.

3. A generator according to claim 1 or claim 2 wherein said distribution chambers comprise two square hollow bodies having a common wall through which the pipe passes.

4. A generator according to claim 1 or claim 2 wherein for the purpose of increasing the measuring range, in addition to the pipe providing said measuring section, at least one further and symmetrically arranged pipe interconnects said distribution chambers, each said further pipe being disposed in the same spatial arrangement with respect to the feed and the discharge in both said distribution chambers, with the same said spacing, as the pipe providing said measuring section.

5. A generator according to claim 1 or claim 2 wherein the parts of said distribution chambers which enclose the two end portions of the pipe each form a respective annular passage which is concentric with the axis of the pipe and through which the fluid flows to one end portion or flows away from the other end portion in a direction opposite to the direction of flow in the pipe.

6. A generator according to claim 5 wherein said two distribution chambers comprise two 180° pipe bends which each extend from a respective connection nipple and which continuously increase in width and which merge into the two annular passages, have the pipe passing therethrough, are held together with connecting elements in their relative positions, and at their enlarged ends carry said measuring transducers.

7. A generator according to any one of the preceding claims wherein the axis of the pipe providing said measuring section is a straight line which is parallel to the common axis of two connection nipples which form the feed and the discharge respectively.

8. A generator according to any one of claims 1 to 3, 5 and 6 wherein the axis of the pipe providing said measuring section is a straight line which forms any angle to the common axis of two connection nipples which form the feed and the discharge respectively.

9. A generator according to any one of claims 1, 2, 5 and 8 wherein said distribution chambers comprise two 90° pipe bends which extend from connection nipples and which continuously increase in width and whose enlarged ends carry said measuring transducers, the axis through the connection nipples forming a right angle to the measuring axis.

10. A generator according to claim 1 or claim 2 wherein the pipe providing said measuring section is bent in a U-shaped configuration and the limb portions thereof each pass through a respective side wall of a respective one of said distribution chambers and pass into said distribution chambers, the end faces of said limb portions being directed towards said measuring transducers which are arranged at the oppositely disposed walls.

11. A measuring value generator substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

12. A measuring value generator substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

13. A measuring value generator substantially as hereinbefore described with reference to Figure

5 of the accompanying drawings.

14. A measuring value generator substantially as hereinbefore described with reference to Figure 6 of the accompanying drawings.

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