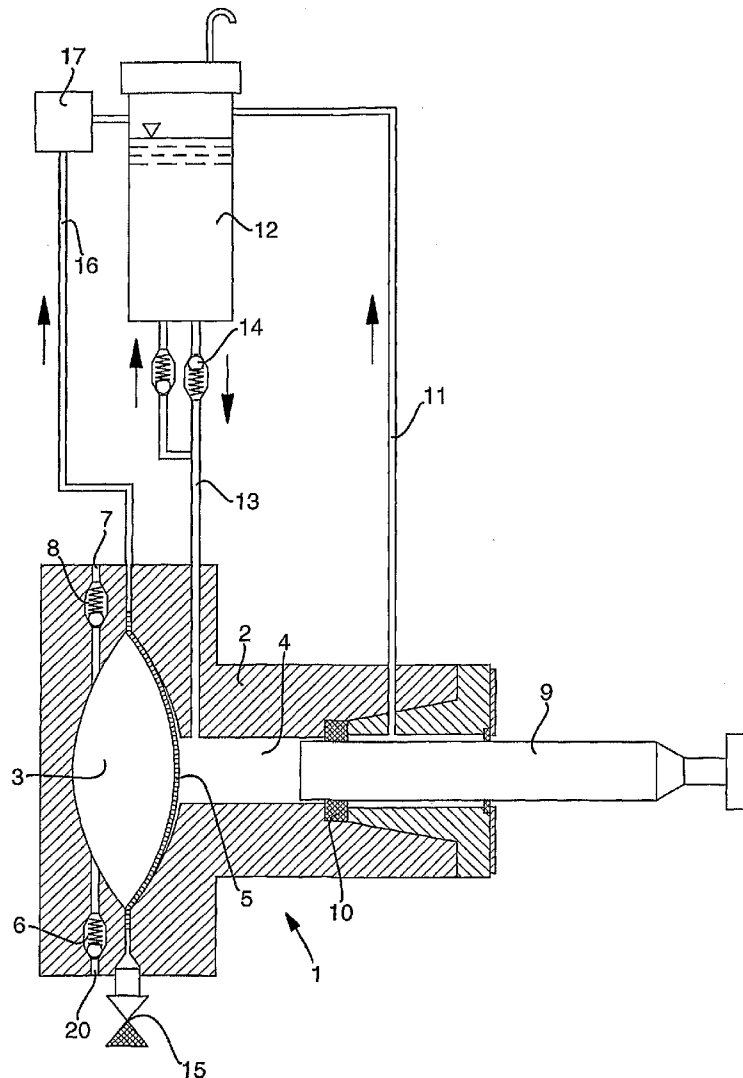




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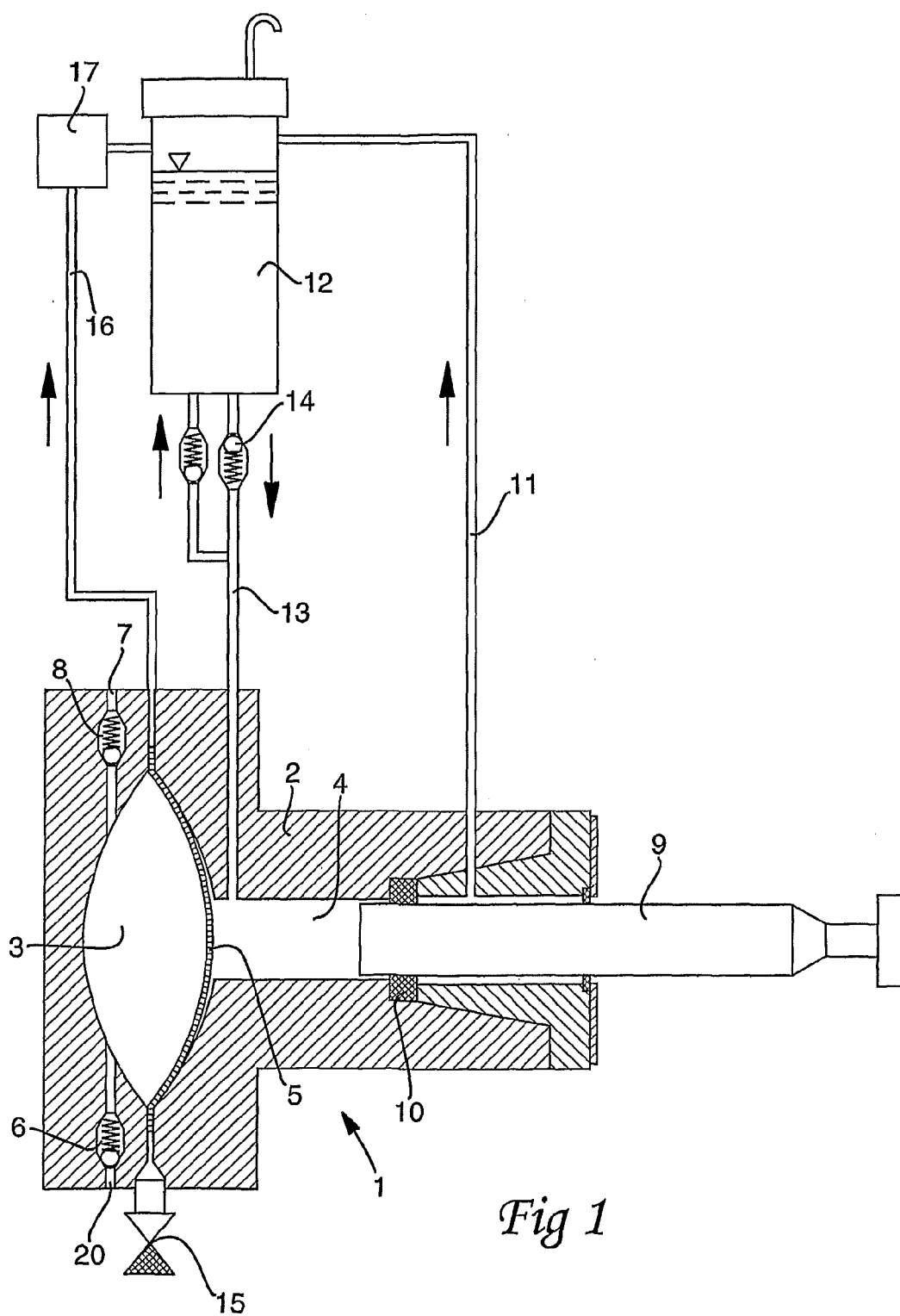
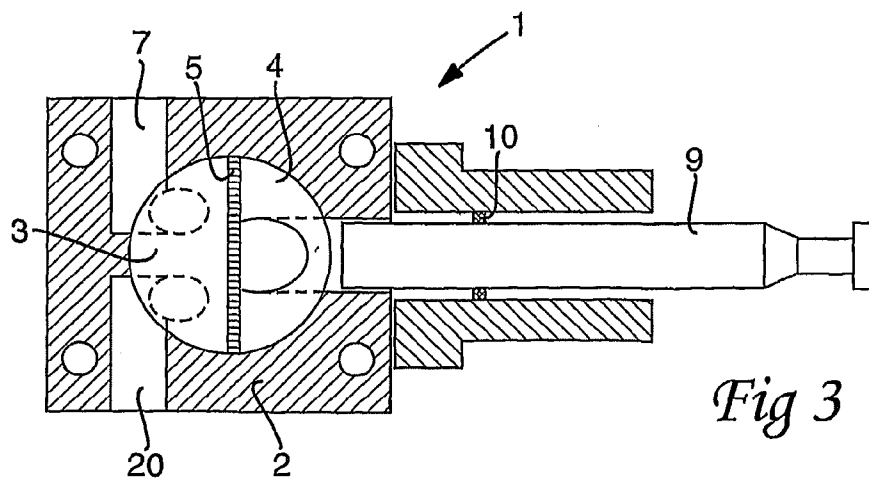
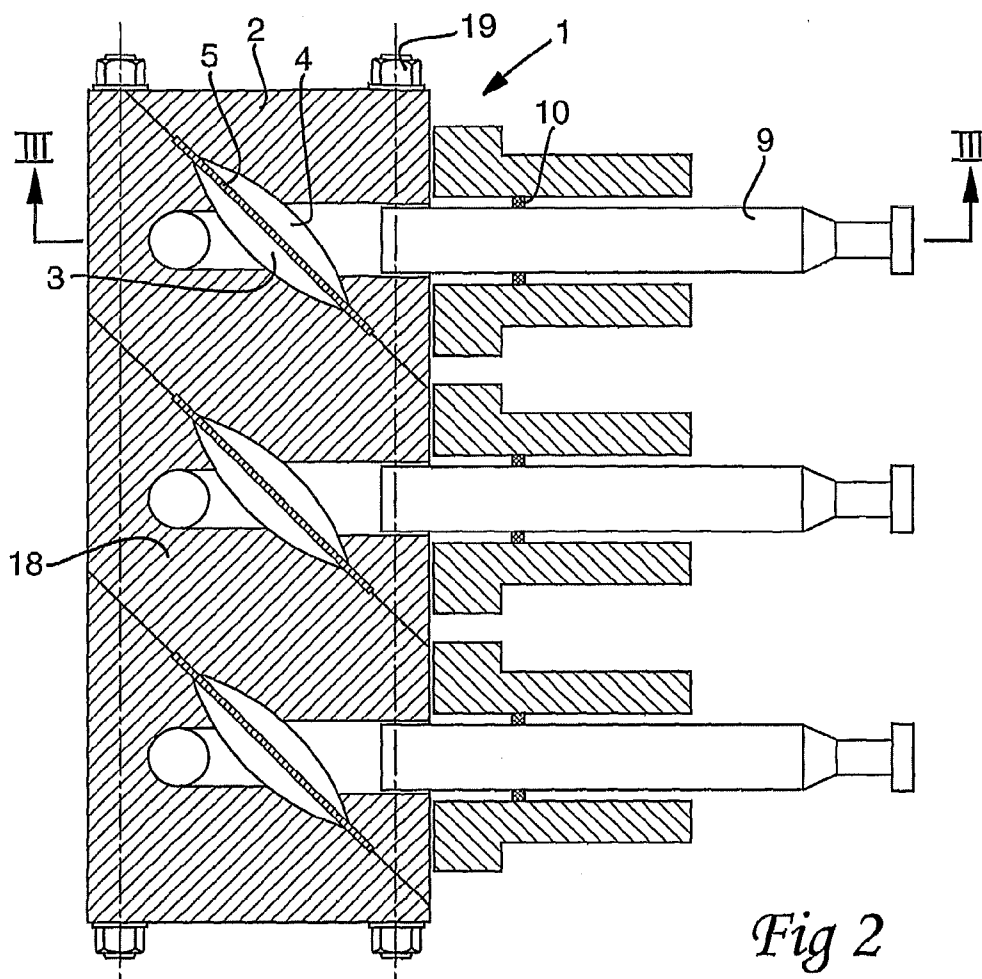


Fig 1



MEMBRANE PUMP HEAD FOR A HOMOGENIZER OR A HIGH-PRESSURE PUMP

TECHNICAL FIELD

[0001] The present invention relates to a membrane pump head for a homogenizer or a high-pressure pump, comprising at least one pump head enclosed in a pump housing, the membrane pump head further including a product chamber with inlet and outlet for the product, and a hydraulic chamber in which a piston is disposed to operate, the product chamber and the hydraulic chamber being separated by a double membrane.

BACKGROUND ART

[0002] Homogenization is an industrial process which has been in use for a considerable time and whose purpose is, in, for example, a fat emulsion such as milk, to split the largest fat globules into smaller fat globules and by such means stabilize the fat emulsion. For, for example milk, this implies that the setting of cream is prevented, and the greater proportion of all consumer milk today is homogenized.

[0003] Homogenization normally takes place by mechanical processing, so that the fat emulsion which is at a high input pressure is forced at high speed to pass through a very narrow gap, whereafter the fat globules of the fat emulsion are broken up, int. al. because of the turbulence which occurs when the fat emulsion leaves the gap at extremely high speed. The high liquid speed gives a low static pressure after the gap, and so cavitation bubbles occur. When the cavitation bubbles implode, extremely high, brief pressure pulses occur which give the considerable forces needed to break up the cell membrane of the fat globules.

[0004] The homogenizers which are currently available on the market essentially consist of a piston pump which creates the high pressure needed for the homogenization, and a counter pressure device, where the actual homogenization takes place. The piston pumps are normally of mechanical construction which convert the rotary movement of the drive motor into a linear movement. The piston of the piston pump is driven by this linear movement.

[0005] The pistons of the piston pump are provided with piston seals which act against the high pressure created in the machine. Since, in food contexts, it is not possible to lubricate the seal, for example by permitting a portion of the product to leak past, the service life of the seals becomes unacceptably short. In addition to the hygienic drawbacks, this would give major product losses. In order for the seals to be effective, they must in addition consist of a relatively soft material, even though they are subjected to the same stresses as the steel in the surrounding machine construction. This also is a contributory factor in their short service life.

[0006] Today's piston pumps which are employed in homogenizers moreover display forged pump blocks which are extremely expensive to manufacture.

[0007] Membrane pumps which are hydraulically driven, i.e. they have a membrane which is driven by the hydraulic fluid which is pumped by a conventional piston pump, do not suffer from the same sealing problems as the piston pumps. This is because the piston seals on the pistons which pump the hydraulic fluid can be permitted to have a minor, controlled leakage of hydraulic fluid which lubricates sealing and piston, since the hydraulic liquid is separated from the product by

means of a double membrane. Such a sealing concept affords an almost unlimited piston sealing service life.

[0008] Membrane pump heads cannot normally be applied on a homogenizer, since the diameter of the membrane must be extremely large in order to correspond with the stroke volume of the existing piston, with the result that a piston pump with membrane pump heads requires a considerably greater centre distance between the pistons than does a conventional piston machine.

[0009] The membrane in a membrane pump head, which is pressure equalized since the same pressure prevails on both sides thereof, divides the head into a product chamber and a hydraulic chamber. As a result, the membrane is not subjected to the pressure difference to which a normal piston seal is subjected and, therefore, may be manufactured from a material which would otherwise not withstand the high pressures which occur. As a result, a membrane pump head is also capable of withstanding considerably higher pressure than a conventional piston pump can meet.

[0010] An apparatus for using a membrane piston pump for homogenization is described in U.S. Pat. No. 6,174,144. Here, a number of pump heads have been positioned in parallel so that hydraulic chambers and product chambers are formed, and where one product chamber and one hydraulic chamber, respectively, are separated by a membrane. A piston acts in each respective hydraulic chamber, and the membranes are oriented so that they are parallel with the pistons. In this embodiment, the pump blocks will be considerably larger and more expensive if there is to be room for membranes of the diameter required by the stroke volume of the piston. This is since the cross section of the pump block must be as large as the diameter of the membrane, plus the space which is required for securing the membrane. Similarly, this embodiment causes a relatively unfavourable pressurization of the membranes and relatively large flow losses.

OBJECTS OF THE INVENTION

[0011] One object of the present invention is to realise a membrane pump head for a homogenizer which enjoys all of the advantages of the membrane pump, without the pump blocks becoming too large in size.

[0012] A further object of the present invention is that the pump blocks will become considerably simpler to manufacture and thereby considerably more economical.

[0013] Yet a further object of the present invention is to realise a favourable pressurization of the membranes.

[0014] Still a further object of the present invention is that the flow losses between piston and membrane are reduced to a minimum.

[0015] Yet a further object of the present invention is that a membrane pump head may be mounted on a conventional piston pump, with retained centre spacing between the pistons.

SOLUTION

[0016] These and other objects have been attained according to the present invention in that the membrane pump head of the type described by way of introduction has been given the characterising feature that the membrane is oriented at 15-75° in relation to the longitudinal direction of the piston.

[0017] Preferred embodiments of the present invention have further been given the characterising features as set forth in the appended subclaims.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0018] One preferred embodiment of the present invention will now be described in greater detail hereinbelow, with reference to the accompanying Drawings. In the accompanying Drawings:

[0019] FIG. 1 is a skeleton diagram of a membrane pump head;

[0020] FIG. 2 shows, partly in section, a top plan view of a pump block according to the present invention; and

[0021] FIG. 3 shows, partly in section, a side elevation of a pump block according to the present invention.

[0022] The accompanying Drawings show only those parts and details essential to an understanding of the present invention, and the positioning of the pump block in a homogenizer, which is well-known to a person skilled in the art, is not shown.

DESCRIPTION OF PREFERRED EMBODIMENT

[0023] FIG. 1 shows a membrane pump head 1, as it may appear in principle. The membrane pump head 1 comprises a pump housing 2 which encloses a product chamber 3 and a hydraulic chamber 4. The product chamber 3 and the hydraulic chamber 4 are separated by means of a membrane 5.

[0024] The product chamber 3 is connected to a product inlet 20. The product inlet 20 is provided with a valve 6. The product chamber 3 is also connected to a product outlet 7. The product outlet 7 is provided with a valve 8.

[0025] A piston 9 acts in the hydraulic chamber 4, which is filled with a hydraulic fluid, preferably oil. The piston 9 is sealed against the pump housing 2 by means of a seal 10. The seal 10 is of a type which withstands high pressure and it is lubricated constantly by the hydraulic fluid. The excess flow of hydraulic fluid is led via the conduit 11 to a hydraulic fluid container 12 which, when necessary, replenishes hydraulic fluid in the hydraulic chamber 4 through the conduit 13 and the non return valve 14.

[0026] The membrane 5 is normally manufactured from a thermoplastic, such as PTFE (PolyTetraFluoroEthylene) or other material approved for use together with foods. Such a membrane 5 has a normal service life of 8,000 hours. Since the membrane 5 is hydraulically supported and pressure equalized, i.e. has the same pressure on both sides, it is not subjected to extreme forces and stresses. Since the membrane 5 is employed in equipment for food production, use is made of a double membrane 5. Between both of the membranes 5, there is a vacuum. The one side of the vacuum space is connected to a non return valve 15 and the other side to a capillary tube 16 which in turn is connected to a pressure sensor 17. Were leakage to occur through one of the membranes 5 breaking or rupturing, the pressure in the capillary tube 16 will rise and the pressure sensor 17 will emit an alarm to the effect that the membrane 5 is defective.

[0027] For reasons of material engineering, the membrane 5 can only move approximately a tenth of its diameter and, as a result, it is the diameter of the membrane 5 which determines the stroke volume of the pump head 1, i.e. the displacement of the piston 9. Since the homogenization process requires a certain stroke volume, a membrane diameter is

necessary which gives the same stroke length for the piston 9 as a conventional piston pump.

[0028] In order to have room for the membrane pump heads 1 in an existing homogenizer, the membranes 5 have been oriented at 15-75° in relation to the longitudinal direction of the pistons 9, as is apparent from FIG. 2. Preferably, the membranes 5 are oriented at 45° in relation to the longitudinal direction of the pistons 9. By orientating the membranes 5 at 15-75° and preferably at 45° in relation to the longitudinal direction of the pistons 9, the size of the pump housing 2 will be reduced to a minimum. For example, in a corresponding pump housing 2, it is possible to have a membrane 5 with an approximately 30% larger diameter than if the membranes 5 had been oriented at 90° in relation to the longitudinal direction of the pistons 9. The membranes 5 are, according to the present invention, arranged in such a manner that it does not affect the size of the machine as a whole. Since the membranes 5 have a physical movement limitation in their direction of movement, this normally entails a necessarily, larger diameter with additional area for a screw union.

[0029] In that the membranes 5 are oriented at 15-75°, preferably at 45° in relation to the longitudinal direction of the pistons 9, there will be obtained a more favourable pressurization of the membranes 5, since the flow angle in relation to the membranes 5 will be much more advantageous. Because of the advantageous flow angle, there will moreover be lower flow losses between piston 9 and membrane 5, which reduces the overall energy consumption of the homogenizer.

[0030] A pump block 18 consists of that number of pump housings 2 which are included in the homogenizer. In FIG. 2, three pump housings 2 are illustrated and are united to form a pump block 18. Each pump housing 2 is supported by the neighbouring pump housing 2, which makes possible pump housings 2 which are smaller than those pump housings which are employed in conventional piston- or membrane pumps. Only the two outermost parts in the pump block 18 need to be reinforced. By integrating together the pump housings 2 according to the present invention, the requirement will be avoided that each pump housing 2 must be sufficiently rigid so as not to give rise to leakage when pressurized.

[0031] The present invention permits the pump block 18 to be held together by means of tie rods 19 which give sufficient resilient properties in the union, at the same time as such a union takes up less space. By orienting the membranes 5 at 15-75°, preferably at 45°, in relation to the longitudinal direction of the pistons 9, there will be obtained, when the membranes 5 are pressurized, approximately 30% less force on the tie rods 19 which hold together the pump block 18. These tie rods 19 act together with the tie rods (not shown) which fix the pump block in the crank mechanism, on the sealing surface of the membrane 5 and seal it. A 30% lower force on the tie rods 19 gives a lower material consumption and makes for smaller dimensions for both the tie rods 19 and the pump block 18.

[0032] The present invention makes it possible to reduce the number of tie rods 19 or union bolts, and as a result the outer dimensions of the pump block 18 will be considerably smaller than for a conventional, circular membrane pump head 1, where a large number of bolts with their associated circular clamping areas are required in order for the membrane pump head 1 to be tight. The present invention also makes it possible to employ tie rods 19 instead of bolts for uniting the pump block 18. By such means, there will also be obtained the resilient properties which are required in the union. In that the present invention makes for a fewer number

of necessary bolts or tie rods 19, there will also be room to integrate the requisite hydraulic fluid ducts in the pump block 18.

[0033] When the piston 9 in a membrane pump moves rearwards, the space in the hydraulic chamber 4 increases. This in turn causes the membrane 5 to move in the same direction as the piston 9. The valve 6 on the product inlet 20 is opened and product is sucked into the product chamber 3. When the piston 9 in a membrane pump moves forwards, the space of the hydraulic chamber 4 is reduced. This in turn causes the membrane 5 to move in the same direction as the piston 9. The valve 8 on the product outlet 7 is opened and the product leaves the product chamber 3 through the product outlet 7.

[0034] Since the product and the hydraulic fluid are hermetically separated and discrete as a result of a double membrane 5, it will no longer in future be necessary to manufacture specific aseptic homogenizers. No parts of the piston 9 come into contact with the product, as in the aseptic machines. The piston 9 need not be sterilized and the total sterilization time of the homogenizer can be reduced. As a result, the steam consumption of the aseptic homogenizers is minimised.

[0035] Today's piston pumps in a homogenizer most generally have water-cooled pistons 9, since these are continuously rinsed with water in order to cool and lubricate and thereby increase the service life of the seals 10. By replacing a conventional piston pump with a membrane pump, the need for water cooling is eliminated and the water consumption of the homogenizers may be reduced radically.

[0036] Since a membrane pump head 1 according to the present invention has double membranes 5, the probability that both of the membranes 5 were to fail at the same time is non-existent. As a result, it is not necessary to stop production in the event of an alarm which indicates that a membrane 5 is defective, but the membranes 5 can be replaced during a normal production stoppage. Naturally, as a matter of routine the membranes 5 should be replaced after a given, predetermined number of hours.

[0037] A conventional homogenizer most generally operates with a pressure of 250 bar. A homogenizer with a membrane pump head 1 can operate with considerably higher

pressure, in particular if the membrane 5 is manufactured from a metal. It is therefore possible in future to manufacture homogenizers which operate at a substantially higher pressure than today's prior art homogenizers.

[0038] As will have been apparent from the foregoing description, the present invention realises a membrane pump head for a homogenizer which enjoys all of the advantages of a membrane pump and which may be retrofitted into existing homogenizers. In that the membrane is angled in relation to the longitudinal direction of the pistons, there will be obtained a smaller pump block than that displayed by existing membrane pumps. Moreover, the pump blocks will be simpler to manufacture and thereby more economical, at the same time as there will be less of an environmental footprint in manufacture. The membrane pump head according to the present invention further displays favourable pressurization of the membrane and flow losses are reduced, which gives lower overall energy consumption for the homogenizer.

1. A membrane pump head for a homogenizer or a high-pressure pump, comprising at least one pump head enclosed in a pump housing, the membrane pump head further including a product chamber with inlet and outlet for the product, and a hydraulic chamber in which a piston is disposed to operate, and the product chamber and the hydraulic chamber are separated by means of a double membrane, wherein the membrane is oriented at 15-75° in relation to the longitudinal direction of the piston.

2. The membrane pump head as claimed in claim 1, wherein the membrane is oriented at 45° in relation to the longitudinal direction of the piston.

3. The membrane pump head as claimed in claim 1, wherein a number of pump housings form a pump block, the pump block being held in union by means of tie rods.

4. The membrane pump head as claimed in claim 1, wherein the membrane is manufactured from a thermoplastic.

5. The membrane pump head as claimed in claim 4, wherein the membrane is manufactured from polytetrafluoroethylene.

6. The membrane pump head as claimed in claim 1, wherein the membrane is manufactured from a metal.

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