

[54] PULSATING FLUID PUMPING SYSTEM

[76] Inventors: **Nikolai Alexandrovich Makarov**, mikroraion "V", 31, kv. 42; **Mikhail Grigorievich Maximov**, mikroraion "G", 1, kv. 31; **Anatoly Matveevich Khokhlov**, mikroraion "V", 24, kv. 24, all of Puschino Moskovskoi oblasti, U.S.S.R.

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Primary Examiner—William L. Freeh
Assistant Examiner—Richard E. Gluck
Attorney, Agent, or Firm—Eric H. Waters

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[58] **Field of Search**..... 128/233, 232, 231;
417/479, 394, 395, 151; 239/339, 338, 22, 23

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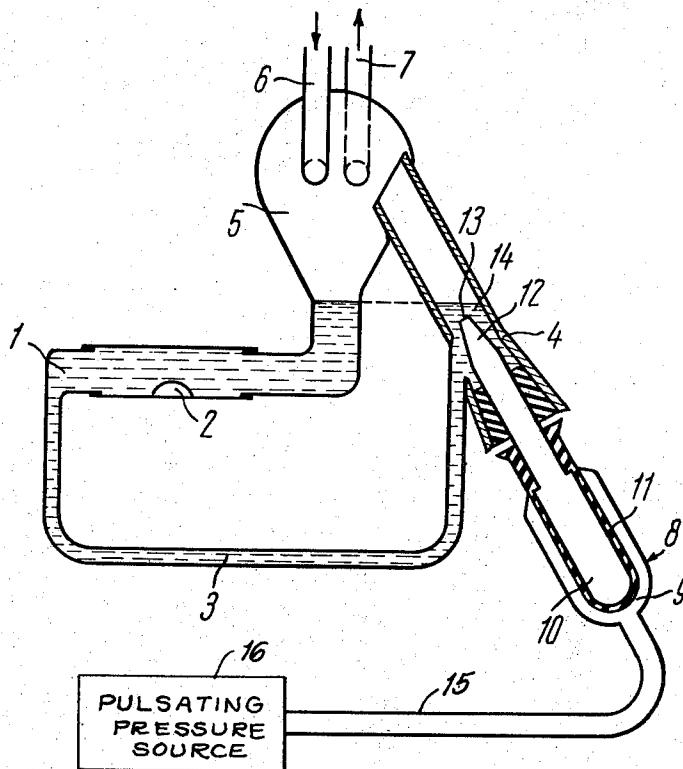
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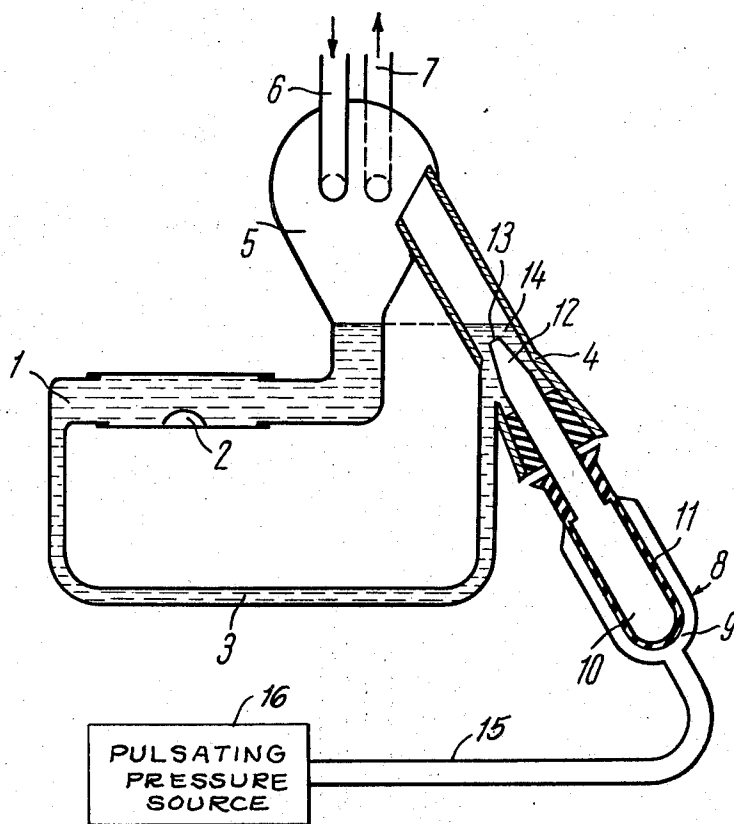
[57] **ABSTRACT**

The pumping system can be utilized wherever pulsatory fluid pumping is expedient or possible.

The system is distinguished by the fact that the positive-displacement pump employed therein is submerged into the fluid being pumped so, that the hole for fluid ejection is located below the level of this fluid, and the inner space of the pump working chamber permanently communicates with the fluid to be pumped.

1 Claim, 1 Drawing Figure





PULSATING FLUID PUMPING SYSTEM

The advantage of this pumping system consists in that it has a simple design and small size, requires a small amount of costly biological fluid compared with existing apparatus of this kind, and prevents the appearance of stagnation zones in the fluid being pumped and the foaming of the fluid as a result of energetic ejection. The latter is an advantage in itself. Exclusion of foaming widens the field of application of these systems. Such systems are to be mainly employed in biological laboratory units where foaming and formation of stagnation zones are not allowable.

The present invention relates to pumping systems, and more specifically to pulsatory pumping systems for fluids, mainly for biological nutrient media in installations to maintain life activity of biological cells and tissues.

Widely known are laboratory pumping units for maintaining life activity of biological tissues and cells. In these units fluid is circulated by a positive-displacement trickling pump consisting of two vessels located at different levels, one of the vessels, the upper one, supplying the fluid through a dropper, and the other, the lower one, receiving the pumped fluid.

The disadvantage of such pumping systems consists in the difficulty to maintain constant pressure in the upper vessel.

To keep pressure at the required level additional devices are used which provide for permanent replenishment of fluid, or regulate pressure in the upper vessel according to a prescribed law. This significantly complicates the unit in production and operation.

Besides that, pumping systems with such pumps have large overall dimensions determined by the mutual disposition of the chamber with the biological tissues or cells, and the supplying and the receiving vessels.

What is more, such a system requires a large amount of extremely hard-to-get nutrient fluid to fill it.

Since units of this type feature certain operating cycles connected with the need to empty the upper vessel, such units require a separate pump for returning the fluid from the lower vessel to the upper one, which further raises the complexity and cost of the unit.

Also known are systems for jerk pumping of molten metals. In these systems the positive-displacement jerk pump consists of two coaxially disposed tubular chambers, the lower end of the inner tubular chamber communicating with the outer chamber, and the upper end of this same chamber extending beyond the outer chamber and being connected with the consumer of the pumped fluid, while the outer tubular chamber has at its bottom inlet holes and at its top communicates with a pulsatory source of compressed air. Such a pump must be submerged to a considerable depth into the fluid metal to be pumped. As pressure is fed to the outer chamber, metal is pressurized into the inner chamber wherefrom under a pressure pulse it flows to the consumer.

(Such systems are known, for example, from a USSR Author's Certificate No. 250,391, cl. 31b2, 39₀₀).

The disadvantage of these pumping systems consists in that the pumped medium therein is liable to foam in the zone of suction. Therefore these systems cannot be used in installations wherein foaming is completely inadmissible. For example, these pumping systems can-

not be utilized in installations for maintaining the life activity of biological tissues.

Another disadvantage of these systems is their low volumetric efficiency, since at each pressurization stroke considerable volumes of the pumped fluid are wastefully thrown out through the suction hole of the pump outer tubular chamber.

One more disadvantage is the slow rate of fluid suction into the outer chamber, as the intensity of suction is only defined by the depth of the pump submersion into the fluid. Increased depth of pump submersion involves enlarged overall dimensions of the pump and of the installation as a whole, and besides, causes formation of stagnant pockets within the fluid volume. The latter circumstance results in the melt freezing. Formation of stagnant zones is always undesirable, especially in installations for maintaining life activity of biological tissues.

An object of the invention is to rule out foaming of the medium in the zone of suction.

Another object is to raise the efficiency of the system.

Further objects of the invention are to improve the suction intensity of the pump and to exclude formation of stagnation pockets in the fluid being pumped.

With these objects in view, in a positive-displacement pumping system serving for pulsatory fluid pumping, according to the invention, part of the pump housing with the fluid ejection hole is submerged into the fluid being pumped so that through this hole the inner space of the pump chamber permanently communicates with the fluid to be pumped.

More particularly, the housing of the positive-displacement pump consists of a chamber having elastic walls enclosed with a clearance in a chamber having rigid walls, wherein said clearance should communicate with a pulsatory pressure source.

Such a pumping system provides for intense ejection of the portion of fluid (which is determined by the pump displacement) and similarly intense suction of a new portion with a minor stirring effect on the fluid in the zone of suction-compression.

Exclusion of foaming is due to the high rate of passage of the fluid portion through the layer of fluid medium, and intense suction is secured by the vacuum built up in the working chamber of the pump.

Following is a detailed description of the invention in a preferred embodiment thereof, namely as applied to an installation for maintaining life activity of biological cells and tissues, with references to the appended drawing which shows the installation to maintain the life activity of biological tissues and cells according to the invention.

BRIEF DESCRIPTION OF THE DRAWING

The FIGURE is a schematic view of the pumping arrangement in accordance with the present invention.

The installation comprises an auxiliary chamber 1 wherein placed are the biological tissue or cells 2, this chamber communicating through a piping 3 with a storage vessel 4 of the biological nutrient fluid.

Vessel 4 communicates with an aerator 5 which in turn communicates with chamber 1.

Pipes 6 and 7 serve, respectively, for delivering and removing a gas medium required to aerate the nutrient fluid. The nutrient medium is circulated by means of a positive-displacement pump 8. The latter consists of

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two chambers located with a clearance one inside the other: an outer chamber 9 and an inner working chamber 10 with elastic walls 11. Chamber 10 in its upper part terminates in a narrowing pipe 12 having rigid walls.

Provided at the end of pipe 12 is a hole 13 for the fluid ejection. The pump is mounted in vessel 4 so that hole 13 of pipe 12 is below the level of the nutrient fluid 14.

Through hole 13 the inner space of the working chamber 10 permanently communicates with the nutrient fluid 14 to be pumped.

The space of the clearance between the outer chamber 9 and the inner chamber 10 communicates by means of an air pipeline 15 with a pulsatory pressure source, i.e. a pneumatic generator 16.

The installation operates as follows.

As an air pulse is fed from the pulsating pressure source 16 through the air pipeline 15 to the clearance between chambers 9 and 10, the elastic walls 11 of chamber 10 are strained.

This causes ejection of a portion of fluid from chamber 10 through hole 13 of pipe 12, this portion of fluid is then thrown onto the wall of aerator 5, wherein circulating gas serves to aerate the nutrient fluid. Circulation of gas is achieved due to delivery of the gas along pipe 6 and its removal through pipe 7. This portion of fluid spills down the wall of aerator 5 into chamber 1 wherein the biological tissue or cells are located.

After the air pulse is stopped the resilient walls 11 of chamber 10 under the effect of elastic forces return to their initial position, fluid 14 being intensely sucked from vessel 4 into chamber 10.

The pulse feeding and stopping cycles are continuously repeated so as to attain a pulsatory supply of the portions of fluid 14 into chamber 1, thus simulating natural life conditions of the biological tissue.

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As the nutrient fluid 14 accumulates in chamber 1, the levels of fluid in vessel 4 and chamber 1 are equalized, so that a current of the nutrient fluid through chamber 1 is realized, and hence, an exchange occurs of this fluid around the biological tissue (cells) 2.

Owing to the fact that the nutrient fluid 14 passes through aerator 5 in small portions and spills down its walls, maximum saturation is achieved of the nutrient fluid with the gases required for the life activity of the biological tissues located in chamber 1.

What we claim is:

1. A pulsatory system for pumping liquids comprising: a positive-displacement pump having two chambers divided by an elastic resilient wall, one of said chambers having an opening for the intake and ejection of liquid, the other one of said chambers communicating with a pulsatory pressure source, said opening for the intake and ejection of liquid being submerged into the liquid to be pumped and allowing a predetermined layer of the liquid to be pumped between said opening and a gas medium said liquid to be pumped is located in a storage vessel; an aerator filled with gas and located over said opening so that each batch of liquid to be pumped and ejected due to a pressure pulse on said elastic wall from said opening through said layer of the liquid being pumped, moves onto the walls of said aerator, spills out over said walls of said aerator while saturated with gas, and spills down outside from said aerator gas supply means for supplying said gas to said aerator; gas removal means for removing gas from said aerator; an auxiliary chamber communicating with said aerator and receiving said batch of liquid from said aerator; and piping connected to said auxiliary chamber and communicating with said storage vessel for circulating liquid from said aerator to said storage vessel through said auxiliary chamber and said piping.

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