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[54] **APPARATUS OPERABLE BY PRESSURE FLUID TO GENERATE PRESSURE WAVES IN A MEDIUM**
4 Claims, 1 Drawing Fig.

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F15b 11/08, E03b 3/00
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[56] **References Cited**
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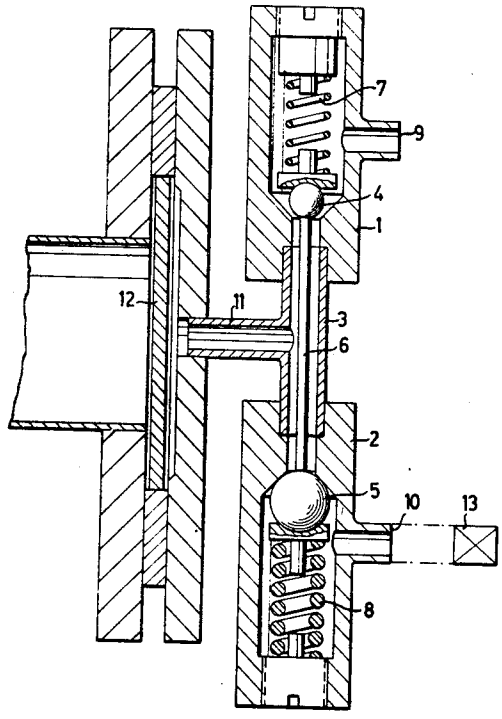
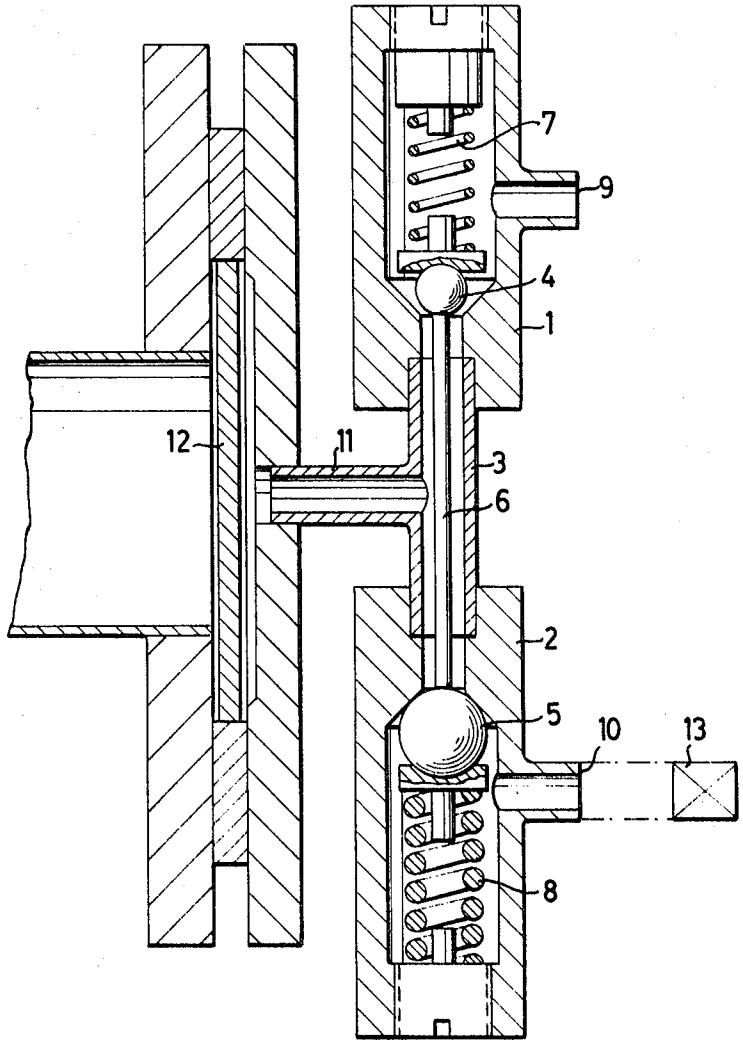
ABSTRACT: An apparatus to generate pressure waves in a preferably liquid and/or gaseous medium, comprising a system of two valves arranged in a cycle flow conduit for a pressure fluid with one valve at each end of a channel surrounding a movable spacer rod so dimensioned that either one of the valves is always in open position. One of the valves is arranged for being opened by lesser pressure than the other. From said channel a branch tube extends to a membrane in contact with a medium, said membrane being adapted to transmit pressure variations generated in the valve system to said medium in the form of pressure waves.





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APPARATUS OPERABLE BY PRESSURE FLUID TO GENERATE PRESSURE WAVES IN A MEDIUM

This invention is concerned with an apparatus operable by pressure fluid to generate pressure waves, preferably in a liquid or gaseous medium.

Energy in the form of pressure waves of relatively great amplitude is nowadays employed in various technical fields, to an extent that is steadily increasing. One of its practical applications resides in in killing of bacteria and sterilization, these effects being achieved in a very satisfactory manner when waste water, especially from hospitals, is treated with such pressure waves. Furthermore, pressure waves have been found to be very useful for effecting transportation of solid materials in liquids, stirring, thickening of suspensions, emulsification etc. The problem with all these practical applications is that they require a nonexpensive apparatus for creating the pressure waves which is safe in operation. Various mechanical or piezoelectric devices have been proposed and employed heretofore, but as a rule these devices have the disadvantage of being very complicated and/or of excessively bulky size.

The present invention provides a very simple and cheap apparatus which is driven by pressure fluid, is safe in operation and has a long useful life.

The chief characteristic feature of the novel apparatus according to this invention is that it comprises a valve system arranged in a cycle flow conduit for the pressure fluid and comprising two valves, one at each end of a channel through which extends a movable spacer rod having a length such that always either one of said valves is in its open position, the valve which is situated at the entrance for the pressure fluid having a valve body smaller than that of the other valve and being adapted to be opened by a lesser pressure than said other valve, said apparatus comprising moreover a branch tube or pipe extending from the channel and a membrance which is positioned on said branch tube, is in contact with the preferably liquid or gaseous medium to be treated and is adapted to transmit pressure variations created in said valve system to said medium in the form of pressure waves.

In a preferred embodiment of the apparatus, a device for reducing the rate of pressure drops arising due to said pressure variations is arranged in the return line of said cycle flow conduit for the pressure fluid.

A preferred embodiment of the apparatus and its manner of operation are illustrated in the accompanying drawing. As shown in the drawing, the apparatus comprises a valve system in the cycle flow conduit for a pressure fluid such as for instance hydraulic oil. The valve system comprises two springloaded ball valves **1** and **2** positioned at the two ends of a channel **3** such as a tube or pipe.

The ball or valve body **4** of valve **1** is smaller than the ball or valve body **5** of valve **2**, their sizes being for example 10 and 15 mm. respectively. The springs **7** and **8** acting upon balls **4** and **5**, respectively, are proportioned in such a manner that valve **2** requires greater pressure for being opened (opening pressure) than valve **1**; these respective opening pressures may be for instance of the order of magnitude of 50—100 kg./cm.^{2} for valve **2** as against 10 kg./cm.^{2} for valve **1**. Valve **1** has an inlet **9** for admitting hydraulic oil from a pump (not shown) while valve **2** has an outlet **10** through which the oil flows back to the pump. Inside the channel **3** there is a spacer rod **6** which is movable back and forth together with and is secured to balls **4** and **5**. Rod **6** is of a length such that always either one of the valves is maintained in the open position, with a play of for instance about 1 mm. As shown, each of the valve seats is tapered, and preferably comprises a conical surface.

Preferably the rod is guided in guide means (not shown) so that it is prevented from lateral movement in the channel **3**. From channel **3** intermediate valves **1** and **2**, a branch conduit **11** extends to a membrane **12** which is in contact with the medium to be acted upon by the apparatus. In a suitable embodiment, the membrane is made of temper-hardened steel.

The apparatus is operated as follows:

In the starting position of the apparatus (as shown in the drawing), valve **1** is open and valve **2** is closed due to the fact that valve **2** has a stronger spring and a larger ball. When hydraulic oil of a pressure higher than the opening pressure of valve **2** is pumped in through inlet **9** valve **2** will open and act on spacer rod **6** so as to close valve **1**, and hydraulic oil will flow out and back to the pump via outlet **10**. When the pressure has fallen valve **2** will close, thereby via rod **6** forcing valve **1** to open. The same procedure is then repeated: Valve **1** closes—valve **2** opens—valve **2** closes—valve **1** opens etc. The pressure variations created thereby in the channel will act on the membrane to make it vibrate, thus generating pressure waves in the medium with which it is in contact. If the apparatus is employed for e.g. mass transportation in a medium it is suitable to arrange on the return line to the pump a means **13**, for example a valve, for reducing the pressure drop rate in the channel. This will result in pressure waves with rapid pressure increase and slower pressure decrease, to thus bring about a sharply defined propulsive force in the medium.

The frequency and amplitude of the pressure waves to be created depend on the practical purpose for which the apparatus is used in each individual case. Usually, the frequency is at least 100 oscillations per second; it is dependent on the length and mass of the spacer rod, the spring coefficient of the stronger spring, and other factors. The amplitudes of the pressure waves may suitably be within the range of about 50 to 100 kg.cm.^{2}.

The apparatus according to the present invention has given extremely good results when employed for destroying contagious matter in sewage or waste water.

Although the apparatus according to this invention is to be used in the first place for generating pressure waves in liquid or gaseous media it has been found useful also for generating pressure waves in solid media. Thus for instance, it may be employed for actuating mechanical tools such as drills for rock drilling, nut tighteners of the impact type, and the like.

It should be appreciated that the apparatus as shown and described above constitutes only one embodiment of the invention and that various modifications may be made therein without transgression of the scope and spirit of the invention.

I claim:

1. An apparatus operable by pressure fluid for generating pressure waves in a fluid medium said apparatus comprising a valve system which is arranged in a cycle flow conduit for the pressure fluid and has two valves, one at each end of a channel surrounding a movable spacer rod which is respectively secured at its opposite ends to one of said valves and has a length such that always either one of the valves is in open position, the valve positioned nearest to the entrance of the pressure fluid into the apparatus having a valve body smaller than that of the other valve and being adapted for being opened by lesser pressure than said other valve, said apparatus further comprising a branch tube extending from the channel intermediate said valves and a membrane which is positioned on said branch tube, is on its side facing away from the branch tube in contact with said fluid medium, and is adapted to transmit pressure variations generated in said valve system to said medium in the form of pressure waves.

2. An apparatus according to claim **1**, further comprising means for reducing the rate of pressure drops arising due to said pressure variations, said means being arranged on the return line of said cycle flow conduit for the pressure fluid.

3. An apparatus operable by pressure fluid for generating pressure waves in a solid medium, said apparatus comprising a valve system which is arranged in a cycle flow conduit for the pressure fluid and has two valves, one at each end of a channel surrounding a movable spacer rod which is respectively secured at its opposite ends to one of said valves and has a length such that always either one of the valves is in open position, the valve positioned nearest to the entrance of the pressure fluid into the apparatus having a valve body smaller than that of the other valve and being adapted for being opened by lesser pressure than said other valve, said apparatus further comprising a branch tube extending from the channel inter-

mediate said valves and a membrane which is positioned on said branch tube, is on its side facing away from the branch tube in contact with said medium, and is adapted to transmit pressure variations generated in said valve system to said medium in the form of pressure waves.

4. An apparatus according to claim 3 further comprising means for reducing the rate of pressure drops arising due to said pressure variations, said means being arranged on the return line of said cycle flow conduit for the pressure fluid.