

[54] **INERTIA PUMP FOR LIQUIDS**

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[52] U.S. Cl. **417/241**

[51] Int. Cl. **F04f 7/00**

[58] Field of Search **417/241, 240**

[56] **References Cited**

UNITED STATES PATENTS

3,077,162	2/1963	Baherian	417/241 X
3,617,153	11/1971	Mowry	417/241
1,764,712	6/1930	Brackett et al.	417/439 X

FOREIGN PATENTS OR APPLICATIONS

582,281	9/1959	Canada	417/241
130,332	7/1920	Great Britain	417/241

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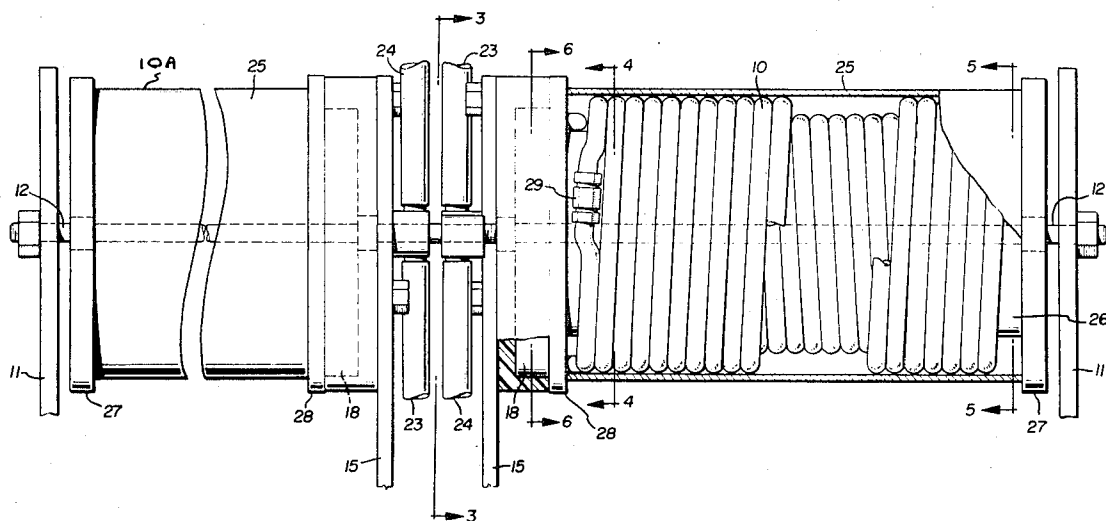
[57] **ABSTRACT**

An inertia pump including an accelerator-tube, forming a helical fluid path, which is either a metal coil or a glass-ceramic material, mounted for rotation about the long axis of the coil, means for reciprocating the coil about the axis, a piping system for supplying fluid to the coil, and for discharging fluid from the coil. A valve assembly inserted into the piping system includes a pair of inlet and outlet check valves for converting a reciprocating flow into a unidirectional flow. A fluid is entrapped within the helical coil which, due to its inertia, generates a pressure when the accelerator-tube is oscillated. This alternating pressure is converted to one direction flow and is utilized to pump fluid through the piping system external to the accelerator-tube. The preferred device has a double set of accelerator-tubes on a common shaft.

The denser the entrapped fluid, the higher the pump pressure.

The accelerator-tube is made from a glass ceramic in one embodiment.

2 Claims, 8 Drawing Figures



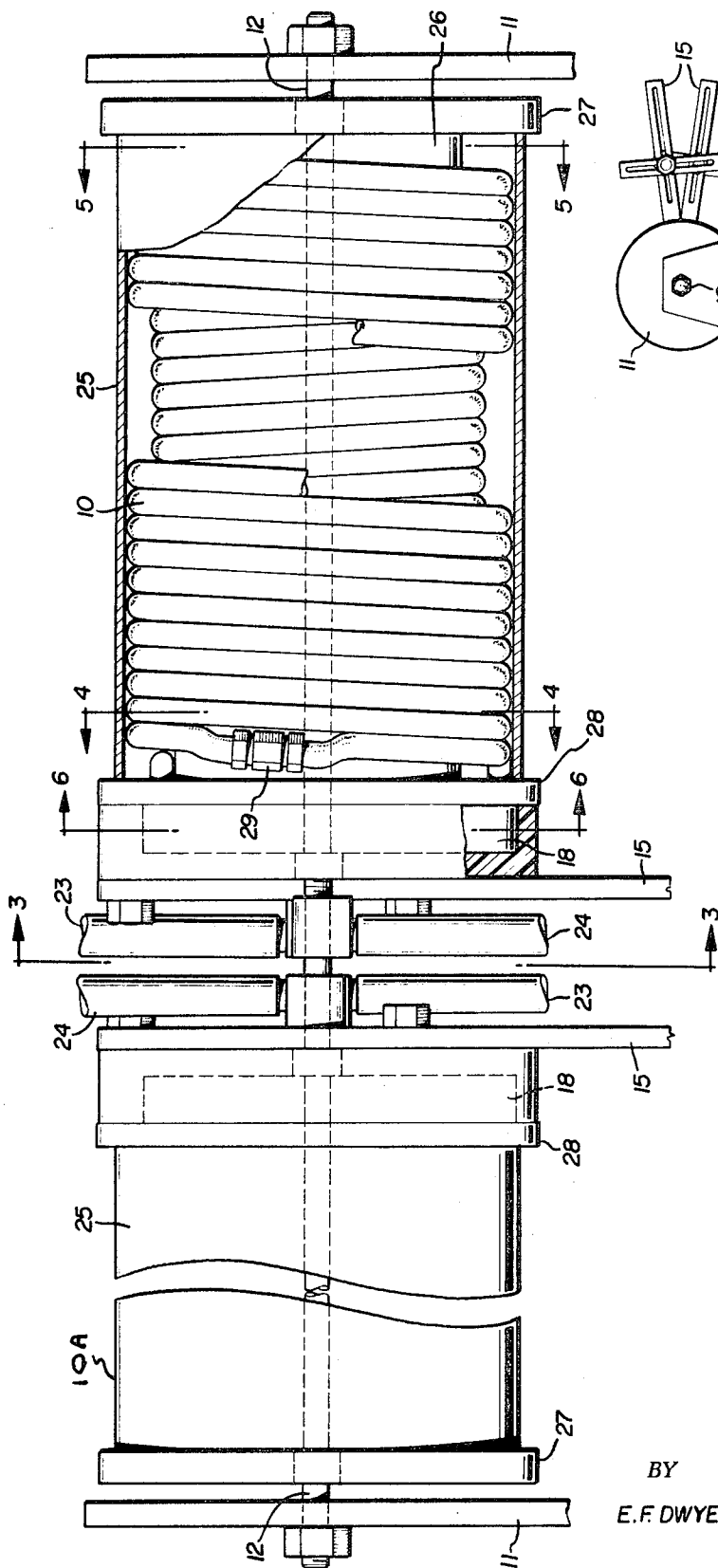


FIG. 1

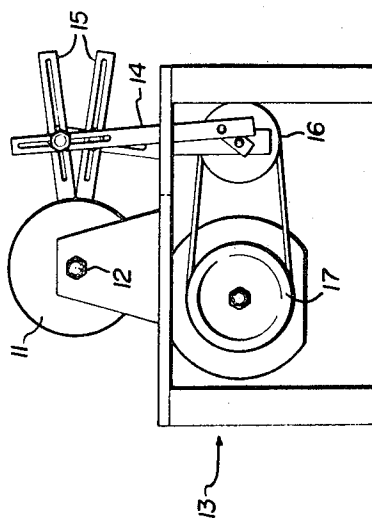


FIG. 2

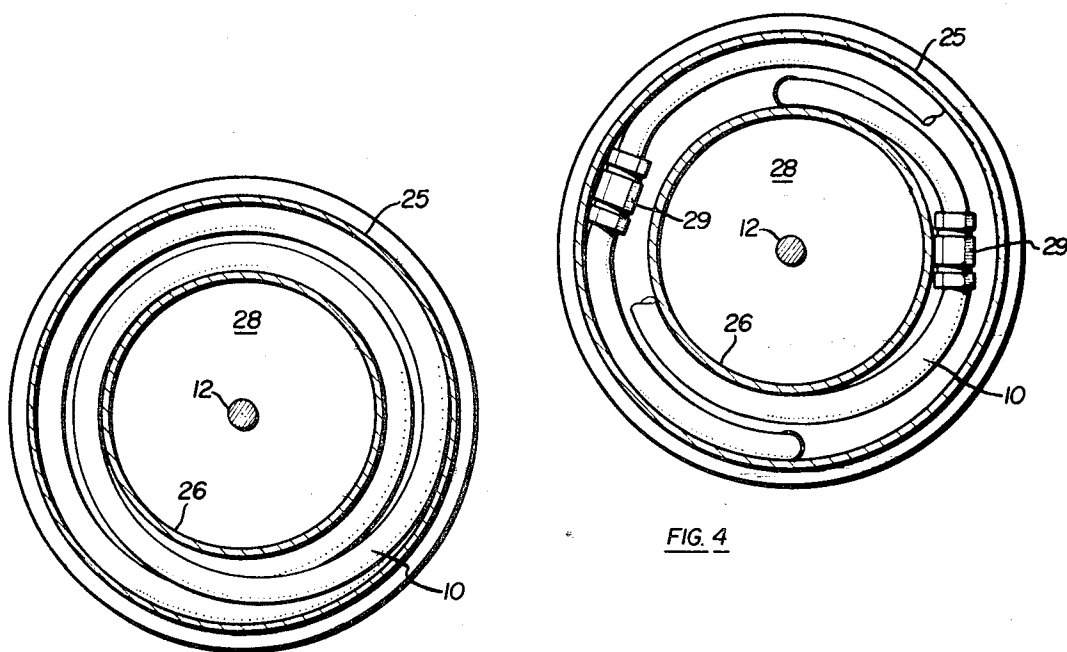
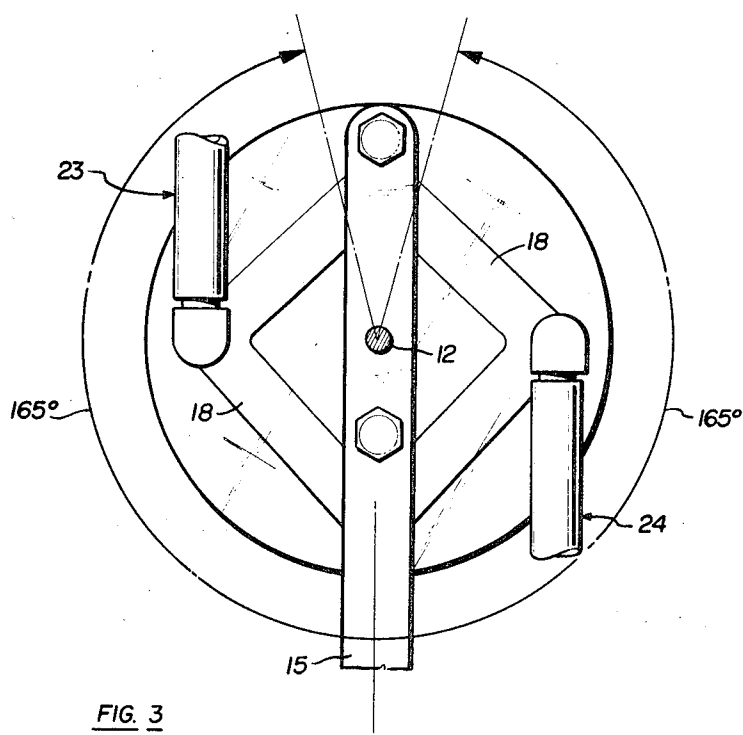
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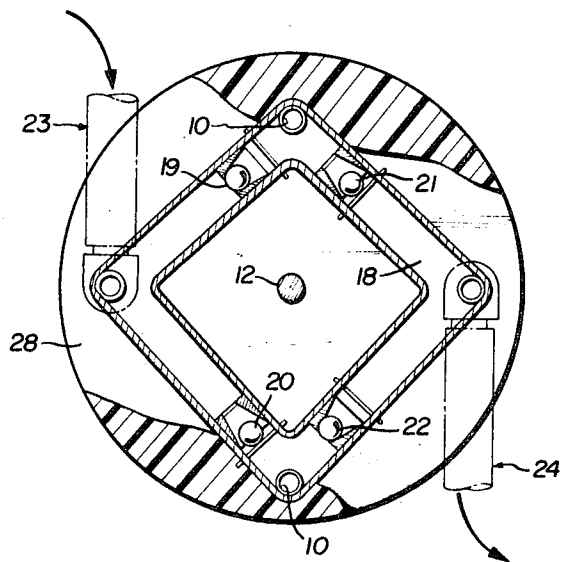


FIG. 6

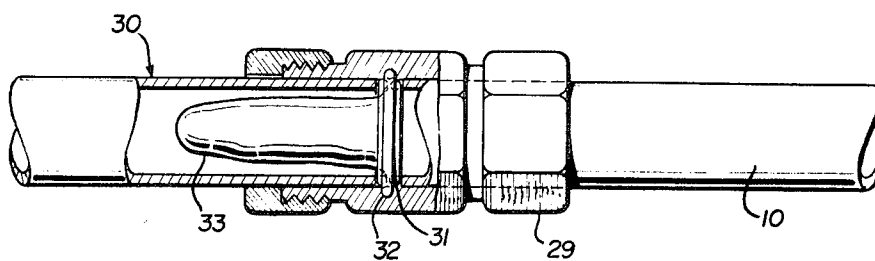
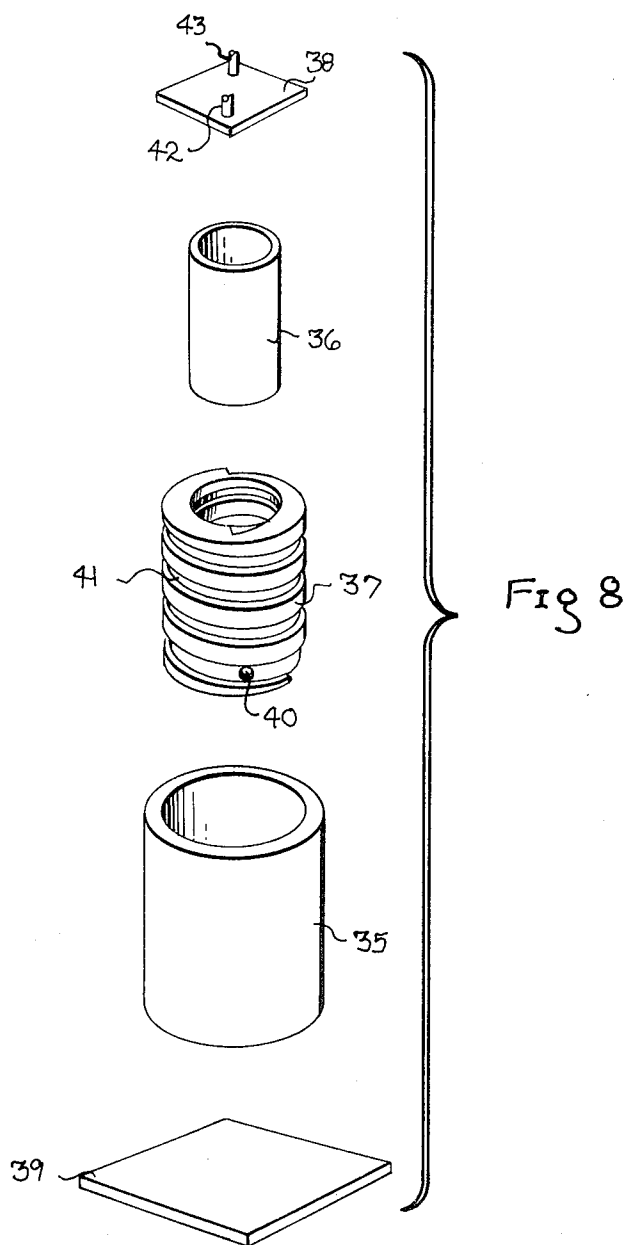


FIG. 7

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INERTIA PUMP FOR LIQUIDS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an improved pump for transporting corrosive, toxic, flammable or biological fluids.

Displacement, rotary and centrifugal type pumps embody one or more impellers and moving parts which contact the pumped liquid; and also a power-transmitting system driving the impeller from an external power source. When pumps of the impeller type are used to transport corrosive liquids, solvents, etc., moving parts and surfaces coming in contact with the liquid must be made from a relatively costly, corrosive-resistant material, or provided with a protective coating which, after a relatively short period of use, is apt to wear or become stripped, thus introducing contamination into the liquid being pumped. Moreover, because such pumps are driven from an external source, it is necessary to use packing glands or like seals which must be periodically replaced in order to guard against leakage. Consequently both the initial cost and maintenance cost of these pumps are relatively high.

The principal objects of the present invention are to provide a pump which has completely sealed fluid carrying systems preventing leakage, such as occurs with conventional centrifugal, vane, piston or rotary pumps; and also to provide an effective and reliable pump capable of handling noxious materials at relatively high pump discharge pressures.

Other objects are to provide pumps capable of handling a fluid containing suspended solids such as abrasive particles, such as encountered in a coolant system for machine tools, to provide a pump which can safely handle toxic materials such as radio-active substances and highly inflammable or explosive fluids, etc., where leakage must be avoided, and by providing a corrosion-resistant material in one embodiment, and to provide a pump the output of which may be varied without changing the speed of the oscillating motive power. An accelerator-tube with alternating fluid flow develops the fluid pressure. The fluid pressure changes activate a rectifying valve assembly to produce a unidirectional flow in an output pipe or discharge system.

DESCRIPTION OF THE PRIOR ART

U. S. Pats. Nos.

991,708
1,304,701
2,354,188
2,918,875
2,936,713
2,938,225
2,972,957 and
3,103,179

disclose pump devices and associated control circuitry. Most of the prior art patents disclose pumps having chambers with check valves at the inlet and outlet of the pump. U.S. Pat. No. 2,948,225 discloses a pump using the inertia of an entrapped fluid in a longitudinally reciprocating tube.

SUMMARY OF THE INVENTION

This invention is an inertia pump having a fluid, trapped in an accelerator-tube. The tube is a double helical coil and in another embodiment a glass ceramic helical fluid path. The tube is rotatable about its longitudinal axis. An input and output piping system and a valve assembly provide a fluid path into and out of the

pump. The accelerator tubes can be arranged in pairs along their longitudinal axes. The inertia of entrapped fluid provides an alternating pressure at the ends of the tube, when the tube is oscillated, and the valve assembly converts the alternating fluid flow to a unidirectional fluid flow.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevation partly in vertical section of an inertia pump of this invention;

FIG. 2 is a side view of a drive for oscillating the accelerator-tube about its axis;

FIG. 3 is an end view of the apparatus of FIG. 1 along line 3—3;

FIG. 4 is an end view of the accelerator-tube, showing the booster valve;

FIG. 5 is a sectional view along line 5—5 of FIG. 1, of the inertia pump accelerator-tube arrangement;

FIG. 6 is a view partly in section of the valve assembly of FIG. 3;

FIG. 7 is a view of a fluid booster, partially sectioned; and

FIG. 8 shows the glass-ceramic accelerator-tube.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description refers to the embodiment of FIGS. 1-6. FIG. 1 shows an inertia pump.

Accelerator coil 10 is supported between a pair of cylinders 25 and 26. The cylinders are held in a telescopic relationship by the end plates 27 and 28, cylinder 26 being smaller than cylinder 25 and positioned inside cylinder 25.

The accelerator-tube is mounted to rotate about its longitudinal axis.

FIG. 2 shows a drive assembly 13 for oscillating the accelerator-tube. The drive comprises a motor 17, connected by a belt to a disc 16. Sliding arm 15 is positioned at one end thereof to the valve assembly 18. Connecting arm 14 is connected at one end to the sliding arm, and at the other end to the periphery of disc 16. The circular motion of disc 16, imparts a reciprocating motion to connecting arm 14, which imparts a pumping motion to sliding arm 15, and oscillates the accelerator-tube and valve assembly about the shaft 12.

The accelerator-tubes 10 oscillate 100° out of phase with tube 10A, to reduce vibrations due to the motion of the apparatus.

Valve assembly 18, shown in FIGS. 3 and 6, is positioned at one end of the accelerator-tube 10. The accelerator-tube 10 is connected to the valve assembly 18 at the tubes' ends, providing a continuous path for liquid flow into the pump and out of the pump.

Referring to FIG. 1, there is a view of the accelerator-tube 10 and valve assembly 18. The tube 10 is helically wound and then doubled back upon the first winding to place the inlet and outlet ends of the tube at the same end and join into the valve assembly 18, providing a continuous fluid path.

The valve assembly 18, FIGS. 3 and 6, is a hollow conduit, square in cross-section forming a fluid path.

A fluid inlet line 23 and fluid outlet line 24 provide a fluid path from a fluid supply to and from the valve assembly.

An inlet check valve 19 and an outlet check valve 21 are positioned in one branch of the fluid path.

Another pair of inlet and outlet check valves 20 and 22 are positioned in another branch of the fluid path of the valve assembly 18.

FIG. 2 is an end view of the drive assembly 13, comprising a connecting arm 14, a sliding arm 15 and a revolving disc 16. The position of the connecting arm relative to the sliding arm is adjustable over a substantial portion of the length of the sliding arm. The position of the connecting arm relative to the center shaft controls the rate of oscillation without a change in motor speed. The disc 16 turns in a circular motion which imparts a reciprocating motion to the connecting arm 14, moving along its longitudinal axis, which, in turn, imparts a reciprocating or back-and-forth motion to the sliding arm 15, rotating the arm only partially about the longitudinal axis of the accelerator-coils mounted on shaft 12. The partial, axial oscillating motion of the sliding arm oscillates the accelerator-tube about its longitudinal axis.

The operation of the inertial pump of this invention is described herein below.

OPERATION

In the inertia pump of this invention, fluid is entrapped within the accelerator-tube 10, an alternating pressure develops at each end of the tube, caused by the build-up inertia of the entrapped fluid which tends to remain in its existing position when the tube moves. As the accelerator-tubes oscillate, a series of alternating pressure increases and decreases are formed at each end of the accelerator-tube. This accelerating pressure causes an external liquid flow in response to the alternating oscillating pressure change in the accelerator-tube. The valve assembly 18 converts the alternating flow to a unidirectional flow. The accelerator-tube is oscillated counter-clockwise, and the pressure to the right of the tube increases. This pressure increase is due to the tendency of non-movement or inertia of the fluid as the accelerator-tube moves past the fluid. The increased pressure opens one of the pair of outlet check valves and also one of the inlet check valves, causing a small portion of the fluid in the fluid inlet line to flow, in a pulsing-like manner. The reverse oscillation of the coil causes a reverse in the pressure points and operates the second pair of inlet and outlet valves, causing a fluid flow through the other path of the valve, resulting in a unidirectional flow of fluid. Theoretically, none of the fluid entrapped in the accelerator-tube flows; however, due to valve action delays, a very small portion of the fluid in the coil actually leaves the accelerator-tube, to insure an absolute separation of the tube line fluids.

FIG. 7 shows an enlarged view in a partial section of an accelerator-booster 29. A booster is inserted into the inlet and outlet of the accelerator-coil. Two accelerator-boosters produce a sealed system wherein the fluid within the accelerator-tube does not contact the fluid in the conduit portions of the system. Fluids are pumped through the external pipe system without any contact with the fluid internal of the accelerator-tube. The accelerator-booster has an outer casing 30, an inner 31 and outer 32 retaining ring. A flexible diaphragm 33 is positioned between the internal and external rings 31 and 32. The pressure pulses within the accelerator-tube, pulses the diaphragm, resulting in corresponding pressure pulses within the fluid of the external piping system. This accelerator-booster is used

when there is a reason for maintaining a separation of the internal and external fluids.

No parts of the pump need be sealed to prevent a fluid loss, and none of the driving section of the pump is in contact with any fluid.

The accelerator-tubes may operate in series, or parallel.

FIG. 8 is a detailed view of another embodiment of the inertia pump of this invention, wherein the accelerator-tube is formed from glass-ceramic material having a high resistance to corrosion and a near zero or even negative expansion as its temperatures increase.

The accelerator-tube has outer shell 35, inner shell 36, and center section 37. The assembled shells and section provide a glass-ceramic fluid path along a spiral 41, on the outside of the center section 37. An opening 40 in the center section provides a fluid path into the spiral on the inside of the center section 37. End plate 38 and end plate 39 cap each end of the assembled shell and central section. An inlet 42 and outlet 43 complete the fluid path. The glass ceramic accelerator is connected to the valve assembly completing the fluid path into and from the pump.

The glass-ceramic accelerator-tube provides a fluid path which is resistant to corrosion, etching, inert to most chemicals and dimensionally stable at elevated temperatures.

The dimensions of the various shells and center passage forming the ceramic may be varied, as required, to regulate pressure and volume flow. The glass ceramic is formed in the manner such as disclosed in Dutch Patent Application, Ser. No. 680,429. The combined ingredients are heated to different temperatures, formed in a mold or press and allowed to cool to room temperature. A subsequent heating converts the material to the glass-ceramic state. This glass-ceramic has a high resistance to acid corrosion, and is very thermally stable. The outer shell 35 and the inner shell 36 provide a water-proof passage when used in conjunction with the center section 37.

In other embodiments, the accelerator-tube may be completely pressed and formed from a one-piece ceramic by forming two halves in a mold and joining the halves along a center plane while the mixture is at a deformable temperature.

A typical example of a heat-crystallizable glass composition is the following, having this composition in parts by weight as follows:

EXAMPLE I

SiO ₂	70.6
Al ₂ O ₃	19.8
Li ₂	3.7
ZnO	1.7
TiO ₂	1.9
ZrO ₂	1.5
Na ₂ O	0.5
K ₂ O	0.1
F	0.1

The mixed ingredients are heated in a suitable gas or electric furnace and brought to a liquid state at about approximately 3000°F. The molten material is transferred from the mixing vessel to a mold. The mold is preferably made from a cast iron or stainless steel material lined with a graphite releasing coating. The molded part is then cooled to room temperature in the mold and removed. The formed part is then placed in an oven and heated to a temperature of about 2000°F, in accordance with a heating schedule as disclosed in

U. S. Patent Application, Ser. No. 630,507, filed Apr. 13, 1967 to Petticrew, Richard W., and subsequently disclosed in corresponding streamlined, continuation application, Ser. No. 866,168, filed Oct. 13, 1969. A Dutch application with the corresponding disclosure of the Ser. No. 630,507, application, was published Oct. 14, 1968. In accordance with the heating schedule disclosed therein, the formed part is heated from room temperature at approximately 50° per hour to about 1350°C. Subsequently, at 150° per hour to about 1950°C; then at about 50° per hour to about 2000°C. where the temperature is held for approximately 1 to 2 hours. The formed and heated material is then cooled at room temperature at about 300° per hour. The glass has a log (4) viscosity at temperatures below about 2490°F.

Other examples of heat-crystallizable glass compositions are shown in Table II on the next page.

TABLE II.—COMPOSITION AND GLASS PROPERTIES

	1	2	3	4	5	6	7
Parts by weight:							
SiO ₂	70.6	70.2	69.2	69.4	68.5	69	68.2
Al ₂ O ₃	19.8	17	17	16.9	19.1	19.6	19.4
Li ₂ O.....	3.7	3.9	3.6	3.5	3.5	3.8	3.8
ZnO.....	1.7	3.6	2.2	2.2	3.1	1.6	1.6
TiO ₂	1.9	1.8	1.8	1.8	1.8	1.8	1.8
ZrO ₂	1.5	1.4	1.4	1.4	1.4	1.4	1.4
P ₂ O ₅		1.5	1.4	1.5	1.5	1.5	2.7
MgO.....			2.2	2			
Na ₂ O.....	0.5	0.4	0.5	0.5	0.4	0.6	0.4
K ₂ O.....	0.1	0.2	0.2	0.2	0.2	0.3	0.2
Sb ₂ O ₃		0.5	0.5	0.5	0.5	0.4	0.4
F.....	0.1	0.1	0.2	0.1	0.1		
Cl.....							
CaO.....							
AP.....	1,280	1,150	1,245	1,240	1,225	1,225	1,250
Lg=4.....	2,480	2,470	2,400	2,440	2,460	2,500	2,505

The explanation of the symbols in Table II is:

AP = annealing point temperature

Lg = temperature at which the logarithm of the glass viscosity in poises is 4.

The inertia pump of this invention provides a pump which is controlled without a throttle, or change in motor speed.

The design provides a pump of greater efficiency, reduced vibration, and virtually no maintenance is necessary.

Some of the many advantages of the inertia pump of this invention are no moving parts of the pump contact the internal or external fluids; no packing is needed; during periods of inactivity, the pump can remain in the line under pressure with little pressure drop; when in operation, no lubrication of the fluid contacting parts of the pump is required. Varying the density of the fluid in the accelerator-tube varies the pressure.

The pressure rise in an inertia pump is proportional

to factors, including the angle of translation of the reciprocating coil, the frequency of reciprocations per time unit squared, the density of the fluid entrapped, and the operating length of the accelerator-tube. This pressure change can be regulated by a change in the angle of translation. The drive assembly of this invention permits easy and rapid regulation of the angle of translation by re-positioning the connecting arm relative to the longitudinal axis of the sliding arm.

I claim:

1. An inertia pump for pumping fluids in a conduit system comprising:

a. an accelerator-tube mounted for oscillation about its longitudinal axis;

b. said tube comprising a continuous helically-wound coil, said helically-wound coil doubled back of itself; the coil having an inlet and outlet at the same end of the accelerator-tube;

c. a valve assembly;

d. said valve assembly positioned at one end of the accelerator-tube and said tube inlet and tube outlet connected to the valve assembly;

e. said valve assembly comprising a hollow, four-sided conduit, forming a fluid path;

f. said valve assembly having outlet check valves and inlet check valves positioned within the valve assembly fluid paths, said valves responsive to changes in the pressure of the fluid flow within the coil assembly;

g. a fluid accelerator-booster inserted in the inlet fluid path and an accelerator-booster positioned in the outlet fluid path, physically separating the accelerator-fluid path from the external conduit fluid path;

h. said accelerator-booster responsive to pressure changes in the coil fluid flow and thereby inducing pressure in the external pipe system;

i. thereby converting the alternating fluid pressure in the accelerator-tube into a one-directional fluid flow in the external conduit system; and

j. means for oscillating said accelerator-tube about its longitudinal axis to produce an alternating fluid pressure in fluids entrapped within the helical coil.

2. The valve assembly of claim 1 wherein the valve assembly comprises:

a. said valve assembly providing a fluid path into two separate branches;

b. an inlet check valve and outlet check valve positioned in a branch;

c. a second inlet and outlet check valve positioned in another branch, so that the oscillation of the accelerator-coil causing pressure resulting from inertia of the entrapped fluid outlet valves, in each branch, provides alternating fluid paths through the assembly valve; and

d. said alternating fluid paths connected to a common exit of the valve assembly, providing a uni-directional fluid flow path.

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