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PUMPING MEANS

FIG. 1.

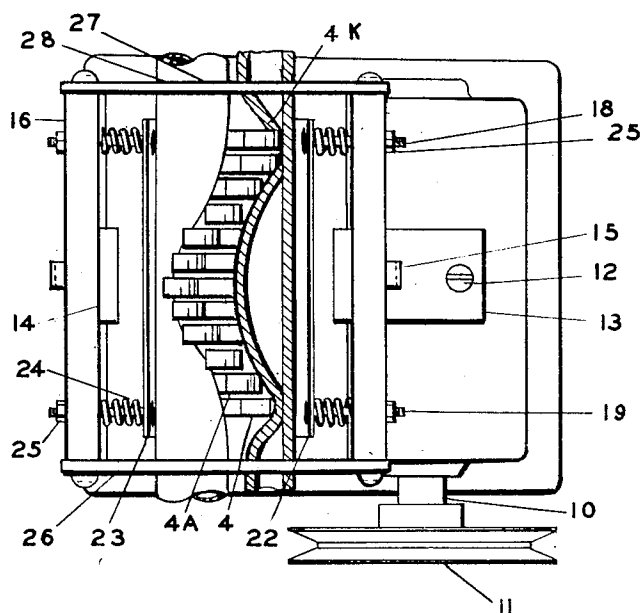


FIG. 2.

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PUMPING MEANS

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My invention relates to improvements in machines for the transfer of fluids through flexible tubing at known and easily adjusted rates. Pumps for such purposes necessitate a careful choice of materials of construction compatible with the fluids to be moved and in some cases it has been necessary to coat all surfaces contacting the fluid with rubber, glass, or other resistant materials which likewise form other parts of the fluid system. Such specially designed pumps are expensive to fabricate and all require unusual and careful techniques to apply them into the system of piping or tubing forming the fluid system. With such apparatus speed changing devices are necessary to readily adjust the rate of flow or in their absence, service interruptions are unavoidable while a mechanic changes the driving means. A very few machines are applicable to fluids carrying solid particles which interfere with the valve action or clog the close clearances of moving parts used to impel the fluids. Failure of any link of the mechanical system has required opening the fluid system while a replacement is being made. Neither can the same simple machine handle a number of different fluids independent of each other at the same time.

My invention which I have called a "Sigma-motor" is a machine for pulsing a flexible tube so as to create a positive unidirectional movement of fluids at rates which vary with the dimensions of the tubing and the frequency of the pulsation. It is not a pump but a mechanism to convert a standard flexible tube forming a part of a fluid system into pumping means. It is easily applied to one or more sections of tubing to form a fluid transfer system having a capacity adjusted by the addition of sections of tubing or by changing the tubes to those of different section, or by combining the tubing so that the flow of the smaller unit is subtracted from the flow from one of larger capacity to give an intermediate rate. Without machine adjustment, it permits the use of tubing ranging in internal diameter over comparatively wide limits and one or more wall thicknesses. It permits machine repair or replacement without opening the fluid transfer system. It allows the use of one machine to create a flow in a number of completely isolated systems or proportions two or more fluids to the same or different systems.

Still another feature not previously available in tube flexing machines assures unidirectional flow without the use of check valves. It measures a uniform amount of liquid for each cycle of operation.

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The flexing of tubing to cause displacement previously has caused excessive wear since the force has been applied in a way that caused undue internal stresses in the walls of the tubing. In most cases one side wall of a section of tubing is displaced along the length of the section a greater distance than the opposing side wall resulting in rapid deterioration and early failures. Again the side walls of the pumping section are not continuously supported requiring thickness and strength in the tube walls both of which adversely affect flexibility.

Friction losses normally occurring in valve operation reduces the efficiency of other pumping means and the lack of streamlined flows provides opportunity for the accumulation of solids in addition to lower efficiency. Special valve mechanism and pumping means have been required to handle fluids containing solid particles or some form of filter to remove such solids must be installed to protect the pump mechanism.

The objects of my invention are, therefore, to provide a simple machine which permits the substitution of a commercial type of flexible tube for normal pumping means, to simplify the rate changing means, to reduce the number of pump and drive mechanisms for any given system, to provide more efficient pumping means at a lower cost to reduce wear and increase life of flexible tubing involved in the transmission of pressure to a fluid system and to transfer solid particles without displacement from their fluid medium.

These objects for improvements in tube flexing machines for the transfer of fluids are attained by the machine illustrated in the accompanying drawings in which: Figure 1 is a side elevation with a section of the base and pulley removed to illustrate the drive mechanism and method of inserting the tubing; and Figure 2 is a top plan showing two pieces of tubing in position one of which is in section.

Similar numerals refer to similar parts in each view.

Supported in a base 1 is a shaft 2 passing through journals 3 of a series of presser bars 4, each of which have contact faces 5 and 6 moved in the arc of a circle by yokes 7 disposed to engage cams 8 fixed with their major axis 9, a uniform angular distance apart. This shaft 10 is journaled in 1 and extends to support the drive pulley 11. Fixed to 1 by screws 12 are supports 13 and 14 which in turn have fixed thereto by screws 15 cross arms 16 and 17. The cross arm 16 is drilled to position bolts 18 and 19 and 17 is likewise drilled to position bolts 20 and 21. These

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four bolts 18, 19, 20 and 21 have their heads countersunk in support plates 22 and a similar group in support plate 23. These plates, 22 and 23 are held against the heads of 18, 19, 20 and 21 by springs 24 which are restrained by nuts 25, bearing on 16 and 17. The tube positioning plates 26 and 27 are supported on the ends of 16 and 17 (right) and 18 and 17 (left) by screws 37. A series of holes such as 28, 29 and 30 are spaced on the left side of 4 and a second series such as 31, 32 and 33 are spaced on the right side of 4 and all a specific distance from 3. Identification numbers 34 on 26 specify the size of tubing to be used in the various holes. Tubes 35 and 36 are inserted to illustrate the relative position of machine parts.

Rotation of the pulley 11 and shaft 10 causes cam 8 to push the yoke 7 and swing 4 about its journal 3 on 2 through the limited arc of a circle advancing face 5 towards 23 and then withdrawing it in each revolution. Likewise cam 8a pushes yoke 7a and swings 4a about its axis but since the major axis 9 and 9a of 8 and 8a are an angular distance apart, the faces 5 and 5a of 4 and 4a are not in the same phase relative to 23 but follow each other a uniform interval apart and progressively press the side walls of 35 together and against 23. When 4a reaches the illustrated position of 4, 4 in turn has begun to move away from 35. Likewise 4k is moving away from 23 and the fluid enclosed between 4 and 4k is being forced along 35 in the direction of 4k. In the meantime 4 has begun to move away from 23 permitting the side walls of 35 to spring apart and receive fluid.

In operation the tubing, 35, forming part of a closed system is drawn through the proper opening, say 30, in tube positioning plate 26 and 27 and between 23 and contact faces 5 of 4. Rotation of pulley 11 causes all presser bars to move in phase with each other causing faces 5 to advance and compress 35 and then to retract and permit it to dilate. Fluids are forced ahead of presser bars 4 which are in the phase of advancing while additional fluid flows in behind the bars 4 that are receding. As presser bars 4 are adjacent to each other they form a continuous support on that portion of the outside of 35 which is under pressure. As the opening of the tubing, to permit the entrance of the fluid to the pumping section is progressively larger as the chamber increases in volume there is no friction loss and no tendency to collapse the tubing by creating a reduced pressure. Solids in the fluid do not collect since there is no change in direction of flow nor any stationary surfaces to accommodate their accumulation.

Since the motion of the presser bars 4 to 4k is in the form of a uniform wave and the tubing is completely collapsed by at least one presser bar at all times, it is evident that the volume displaced by one revolution or cycle is always the same. Therefore, given a specific size of tubing the volume delivered per unit of time is proportional to the number of revolutions. Using a machine driven at a fixed rate, a known volume will be delivered. Inserting one or more additional tubes through their proper openings and connecting them into the fluid system in parallel permits increasing the rate of flow proportional to the size and number of tubes. By connecting the suction end of a smaller section to the discharge end of a larger section an intermediate rate equal to the difference in capacity of the two sizes is obtained. Figure 1 illustrates two

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tubes connected in parallel as could be used to proportion two fluids into a common line.

As the tube support plates 22 and 23 are supported in planes parallel to the faces 6 and 5 respectively of bars 4 when at the limits of their travel the reaction to displace the tubing away from the journal 3 is small and by placing the journal 3 below the tube position, the weight of the tube and contents is permitted to counteract the reaction. I have found that, by limiting the angularity of the presser bar displacement to about one-inch at a distance of eight inches from the journal 3, the force of gravity is counterbalanced and that a section of tubing does not tend to creep either up or down but remains approximately horizontal between the supports 26 and 27. Again the presser bars 4 are moved at right angles to the axis of the tubing and have no movement along this axis. Longitudinal strains in the resilient walls, normal to other tube flexing machines, are eliminated and the reaction of the liquid pressure is directly born by the presser bars 4. I have found that this arrangement eliminates all appreciable external wear on commercial grades of resilient tubing.

The method of attaining the advantage of using a single machine to create the pumping means for a number of different fluids at one time is self evident. I have used a single machine to produce vacuum, to compress air, to circulate cooling water and to meter a fluid feed, all at the same time. It is also evident that two or more separate processes can be served by a single unit by bringing through it flexible tubing connected into those systems.

The wave motion of presser bars 4 permits one bar to completely collapse the tubing against either of the tube support plates 22 or 23 and thereby prevents the reverse flow of liquid and eliminates the necessity for a valve system. These support plates 22 and 23 are resiliently supported on springs 24 to allow for slight deviations in wall thicknesses normally occurring in commercial sizes of flexible tubing and to prevent undue compression of the tube material should solid materials be trapped at that section under the presser bar. The motion of the bars, however, is such that the velocity in the fluid is greatest just as the side walls are about to touch each other and this instantaneous local high velocity tends to sweep out solid particles in the direction of flow. These features make the machine in combination with a flexible tube efficient and economical means for the pumping of slurries and solid contaminated fluids.

In practice it has been found expedient to space the support plates 22 and 23 at different distances from surfaces 6 and 5 respectively so that a range of tubing in two different wall thicknesses can be accommodated. For example, in laboratory machines the spacing on one side permits the use of tubing having a one-eighth inch wall thickness while on the opposite side the spacing permits the use of three-sixteenth inch wall thickness.

I am aware that previous to my invention fluids have been made to flow in flexible tubing by the external application of pressure, and that the rate of the resultant flow has been varied by changing the frequency of the pulsations. I, therefore, do not claim broadly a machine for this purpose, but:

I claim:

1. Pumping means comprising a frame having a pair of spaced walls, a shaft supported in the

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frame, a series of presser bars journaled on the shaft to provide a common pivotal axis therefor, each said bar having a tube-engaging arm extending upwardly between said walls and a laterally extending cam engaging arm, a second shaft journaled in the frame, a series of cams fixed to the second shaft, each cam engaging one of said cam-engaging arms, a plate having a tube-supporting surface mounted in the frame between said walls in opposed relation to said tube-engaging arms, said presser bars being successively oscillatable about the first shaft through a common arc in response to rotation of said cam shaft to swing said tube-engaging arms towards said tube-supporting surface, resilient means engaging the opposite surface of the plate and normally maintaining said tube-supporting surface in a plane parallel to the adjacent faces of said tube-engaging arms when at the limit of their approach to the plate, said walls having a pair of aligned tube-receiving and positioning openings therein located between said tube-engaging arms and said plate, and a flexible tube extending through said pair of openings between said presser bars and tube support plates.

2. Pumping means as defined in claim 1 wherein said common arc has a magnitude of approximately one inch and a distance of approximately eight inches from said common pivotal axis.

3. Pumping means comprising a frame having a pair of spaced walls, a shaft supported in the frame, a series of presser bars journaled on the shaft to provide a common pivotal axis therefor, each said bar having a tube-engaging arm extending upwardly between said walls and a laterally extending cam-engaging arm, a second

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shaft journaled in the frame, a series of cams fixed to the second shaft, each cam engaging one of the cam-engaging arms, a pair of tube support plates resiliently mounted in the frame between said walls, one of the plates being positioned forwardly of the tube-engaging arms and the other of the plates being positioned rearwardly of the tube-engaging arms, said walls having a plurality of pairs of aligned tube receiving and positioning openings located between said support plates, said presser bars being oscillatable in consecutive order through a common arc in response to rotation of the cam shaft to swing the tube-engaging arms towards and away from the support plates, and a flexible tube extending through each pair of openings between said presser bars and tube support plates.

4. Pumping means as defined in claim 3, the degree of forward or rearward movement of each tube-engaging arm being slightly greater than the internal diameter of each tube.

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