

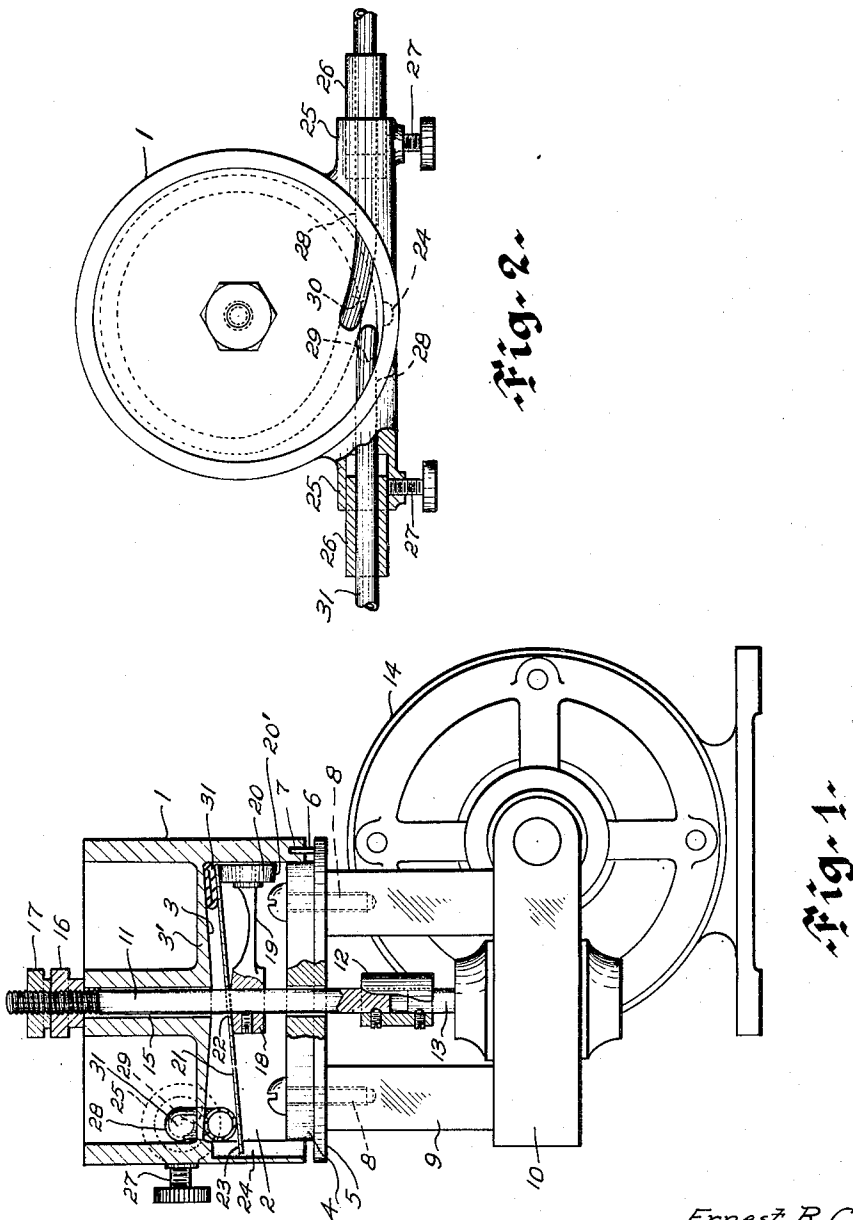
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TUBE FLEXING PUMPING MACHINE

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TUBE FLEXING PUMPING MACHINE

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This invention relates to flexible tube pumping machines.

The transfer of fluids is a fundamental step in many chemical and like processes as carried out in biological, medical and industrial laboratories and other establishments. It is recognized that the uniform transfer of liquids at very small flows becomes increasingly difficult and the need for positive means therefor, which is simple and easy to install, has become more evident in recent years even though a great many different types of laboratory pumping equipment are available.

It has been found that pumping means based upon the manipulation of flexible tubing has the ability to handle most fluids and even those carrying a considerable burden of solid matter. Flexible tubing made from plastics is available to convey almost all fluid chemical substances and is an ideal material of construction for valveless pumping means which offer simplicity in the fluid passages. Machines for manipulation of this pumping means have not been simple mechanically. They have not provided for means to vary the flow of a simple conducting tube without changing the speed of the driving means. Heretofore, the tube length being acted upon has been fixed to a single dimension by the design of the manipulating machine and no change in volume being delivered could be attained by this means. Both of these features have been diligently searched for by the medical profession and engineers in various types of research.

An object of this invention is to provide a tube flexing machine for the manipulation of flexible tubing which includes means for varying the pumping capacity of a flexible tube of given length and which also includes means for adjusting the rate of flow by varying the length of a pumping member. A further object is to provide a tube flexing machine of simplified structure wherein relatively few moving parts are required.

Other objects, details and advantages of the invention will become apparent from the following description, with reference to the accompanying drawing, in which

Figure 1 is a vertical cross-section of a machine constructed in accordance with the invention, and

Figure 2 is a top plan view.

Referring to the drawing, 1 is a vertically disposed cylindrical body recessed to provide a lower cylindrical chamber 2. The bottom surface 3 of the recess defined by the upper wall 3' of the chamber has a flat conical configuration with its apex extending downwardly. A circular cover

plate 4 is provided at the lower end of chamber 2, such plate engaging the inner wall surface of the chamber or recess. The plate has a lower peripheral flange 5 which carries a dowel pin 6 extending into a complementary opening 7 in the wall of the chamber. The plate 4 is fixed by means of screws 8 to supports 9 carried by a frame member 10. It will be observed that the plate 4 and pin 6 provide a guide for and permit relative vertical movement of the body 1 with respect to the plate while restraining the body from relative lateral movement. A vertically disposed driven shaft 11 is coupled at 12 to a shaft 13 mounted in frame member 10 and driven by any suitable means from motor 14. Shaft 11 is journaled in an axial opening 15 in the body 1 and extends axially through cover plate 4. An adjusting nut 16 on the threaded upper portion of shaft 11 engages the upper surface of body 1 to adjust the vertical position of body 1. The nut 16 is locked in position by a lock nut 17.

Fixed to the shaft 11 within the chamber 2 and spaced from the conical wall 3 is a hub 18 having a radially extending resilient arm 19 on the end of which a roller 20 is rotatably mounted. Roller 20 is located closely adjacent the side wall of chamber 2 and is adapted to revolve about the inner periphery thereof.

A flat circular plate 21 is supported on hub 18 within chamber 2 and has an axial opening 22 through which the shaft 11 extends. Opening 21 is of larger diameter than that of the shaft to permit tilting of the plate about the shaft. The peripheral portion of the plate is engageable by the roller 20, the diameter of which is such that it supports the plate in tilted position about the axis of shaft 11. Preferably, the edge surface 20' of the roller is inclined to permit full engagement of such surface with the plate. The plate is provided with a tab 23 which extends into a groove 24 in the wall of chamber 2, to restrain the plate from turning movement.

Mounted substantially tangentially on body 1, and in opposed relation to each other, are a pair of tube holding guides 25, each of which is arranged to receive a tube supporting sleeve 26, a screw 27 being provided to retain the sleeve in position within the guide. The guides 25 are located on a level above wall 3' and in axial alignment with each guide is an opening 28 in the upper side wall of body 1. In transverse alignment with one of the guides and corresponding opening 28 and in adjoining relation to the inside wall surface of the body is a tube inlet opening 29 in wall 3'. A tube outlet opening 30 is also pro-

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vided in wall 3'. Outlet 30 closely adjoins inlet 29 but is circumferentially and laterally offset therefrom. Outlet 30 is not less than 360° rotation-wise apart from inlet 29 and is in approximate alignment with the other guide and corresponding opening 28.

In operation, the flexible tube 31, through which liquid is to be pumped, enters the device through one of guides 25 and openings 28, and through inlet 29 into chamber 2, thence around the peripheral portion of the chamber, as shown in Figure 2, above plate 21, through outlet 30, and thence through the other opening 28 and guide 25. The adjusting and lock nuts 16 and 17 are then actuated to move body 1 downwardly to close the space between wall 3' and plate 21 to an extent where the tube 31 is collapsed at one portion thereon between roller 20, plate 21 and wall 3'. Since the top surface of hub 18 on which the plate 21 rests is in a plane lower than that of the upper surface of roller 20, the plate is tilted, thus providing a completely relaxed portion of the tube diametrically opposite the collapsed portion. As the roller revolves, in response to rotation of shaft 11, the compressed and relaxed portions of the tube move around the section of the tube between inlet 29 and outlet 30.

As the roller passes over inlet 29, that portion of the tube behind the roller begins to assume a relaxed position, thereby causing a suction which follows around the tube behind the point of compression. This condition causes fluid admitted to the entrance end of the tube to flow into the section of the tube within the chamber 2. However, as the roller makes one revolution, it momentarily pinches the tube at inlet 29 and traps the fluid drawn in ahead of the point of compression. This fluid then begins to flow out through the outlet portion of the tube at 30 and continues to flow until the roller passes over outlet 30, when the next pumping cycle commences. Since inlet 29 and outlet 30 are more than 360° apart, the tube is always collapsed at one point and positive displacement results.

Since arm 19 is resilient, adjustment of nuts 16 and 17 to draw roller 20 beyond the point of collapse of tube 31 causes bending of the arm. This permits the top surface of hub 18 to bear against plate 21 and limits its displacement from the plane at right angles to the axis of shaft 11. This limitation causes plate 21 to bear on tube 31 at the normally relaxed position diametrically opposite roller 20. Thus, the tube may be partially collapsed at its point of inlet, thereby to restrict the volume of fluid which can be drawn in, and in turn, the amount of discharge. It is, therefore, possible to adjust the capacity as desired subject to the maximum capacity of the tube.

In the normal insertion of pumping member 31 into chamber 2, one end is threaded through inlet sleeve 26, which is in turn slid along tube 31 and fixed, leaving sufficient length to permit the end of tube 31 to be threaded through guide 25 and inlet 29, around chamber 2, and through outlet 30 and the other guide 25. The other sleeve 25 is then slipped onto the tube and positioned to permit the maximum length of tube 31 in the chamber 2. The sleeves will bear on the bottom of guides 25 when the tube is in this position. Should it be desired to reduce the length of tube 31 within chamber 2, either or both of the sleeves are slid out of their guides, respectively, after loosening screws 27, until the tube section in chamber 2 is shortened to adjust

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the flow as desired, and the sleeves again locked in position in the guides. To again increase the pumping capacity, the process is reversed. Since the pumping capacity of the tube is proportional to the length being operated upon in chamber 2, it can readily be seen that the length adjustment adjusts the volume of fluid delivered. Such adjustment can be made while the device is in operation.

It will be apparent that various changes may be made in the mechanical details described while remaining within the scope of the invention as defined in the appended claims.

I claim:

1. A tube flexing machine for pumping fluids comprising a body having top and side walls defining a tube-receiving chamber therein, a substantially vertically disposed shaft journaled in the body and extending through the chamber, means normally maintaining said top wall in a fixed plane with respect to the shaft, a radially extending arm fixed to the shaft within the chamber, a roller rotatably carried by the free end of the arm on an axis at right angles to the axis of the shaft, a tube-engaging plate in the chamber and encircling the shaft and constituting a movable bottom wall of said chamber, a tube having a portion extending through said chamber and around the shaft in unattached relation to said top and bottom walls, said plate being tiltable about the axis of the shaft to squeeze said tube portion between said top and bottom walls, means fixed to the shaft having a surface engaging and supporting the axial portion of the plate, said roller engaging the under surface of the peripheral portion of the plate and supporting the same, the plane of the plate-engaging surface of the roller being spaced above the plate-engaging surface of said means, and means for driving said shaft.

2. A tube flexing machine for pumping fluids comprising a body having a tube-receiving chamber therein and a transverse wall constituting the top of said chamber, means normally maintaining said transverse wall in a fixed plane with respect to the shaft, a substantially vertically disposed shaft journaled in the body and extending through the chamber, means for adjusting the vertical position of said body with respect to the shaft, a radially extending arm fixed to the shaft within the chamber, a roller rotatably carried by the free end of the arm on an axis at right angles to the axis of the shaft, a tube-engaging plate above the arm and roller in the chamber and encircling the shaft and constituting a movable bottom wall of said chamber, a tube having a portion extending through said chamber and around the shaft in unattached relation to said top and bottom walls, said plate being tiltable about the axis of the shaft to squeeze said tube portion between said top and bottom walls, means fixed to the shaft having a surface engaging and supporting the axial portion of the plate, said roller engaging the under surface of the peripheral portion of the plate and supporting the same, the plane of the plate-engaging surface of the roller being spaced above the plate-engaging surface of said fixed means to maintain the plate in tilted position with one portion thereof in closer relation to the top of the chamber than the remaining portion, said adjusting means acting to move the top of the chamber towards or away from said plate, and means for driving the shaft to revolve said roller.

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3. A tube flexing machine as defined in claim 2, including a tube inlet and a tube outlet in said top wall of the chamber arranged to permit passage of said tube therethrough for insertion between the top wall and said plate.

4. A tube flexing machine as defined in claim 2, including a tube inlet and a tube outlet in said top wall of the chamber arranged to permit passage of said tube therethrough for insertion between the top wall and said plate, said inlet and outlet being positioned adjacent the periphery of the top wall, and being spaced more than 360° apart circumferentially of axis of the shaft.

5. A tube flexing machine as defined in claim 2, including a tube inlet and a tube outlet in said top wall of the chamber to permit passage of said tube therethrough and positioned adjacent the periphery thereof, said inlet and outlet being spaced more than 360° apart circumferentially of the axis of the shaft, and said arm being resilient to permit flexing thereof in response to upward movement of said fixed plate-engaging means beyond the limit of upward movement of said roller.

6. A tube flexing machine for pumping fluids comprising a body having a substantially cylindrical chamber in the lower portion thereof and a transverse wall constituting the top of said chamber, a substantially vertically disposed shaft journaled in the body and extending through the chamber, means for driving said shaft, a radially extending resilient arm fixed to the shaft within the chamber, a roller rotatably carried by the free end of the arm on an axis at right angles to the axis of the shaft, a circular plate above the arm and roller in the chamber and having an axial opening through which said shaft extends, said opening being larger in diameter than the shaft to permit tilting of the plate thereabout, a shoulder fixed to the shaft and having an upper surface engaging and supporting the axial portion of the plate, said roller engaging the under surface of the peripheral portion of the plate and supporting the same, the plane of the plate-engaging surface of the roller being spaced above the plate-engaging surface of the shoulder to maintain the plate in tilted position, a tube inlet and a tube outlet in said top wall, a tube section extending through said inlet and outlet and having a portion extending around the

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peripheral portion of the chamber and between said plate and top wall, and means for adjusting the vertical position of said body with respect to the shaft to collapse one part of said tube portion between said plate and top wall, the tilted position of said plate permitting the tube part of the portion diametrically opposed to said collapsed part to remain at least partially uncollapsed.

7. A tube flexing machine as defined in claim 6, including a tube supporting sleeve for each of the inlet and outlet portions of the tube, and a guide mounted on the body and removably supporting each sleeve.

8. A tube flexing machine for pumping fluids comprising a body having a substantially cylindrical chamber in the lower portion thereof and a transverse wall constituting the top of the chamber, a shaft journaled in the body and extending axially through said chamber in substantially vertically disposed position, a plate tiltably carried by the shaft and constituting a movable bottom wall of the chamber, an arm fixed to the shaft, a roller carried by the arm and engaging the plate to tilt it about the shaft, a tube having a portion extending through said chamber and around the shaft in unattached relation to said top and bottom walls, means for maintaining said transverse top wall in a fixed plane with respect to the shaft and for vertically adjusting the position of said top wall with respect to the shaft, and means for driving the shaft to revolve the roller.

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