Feb. 28, 1961 D. W. JONES 2,973,004

ORIFICE PLATE AND SOLENOID VALVE FOR GRITTY LIQUIDS

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FIG. 1

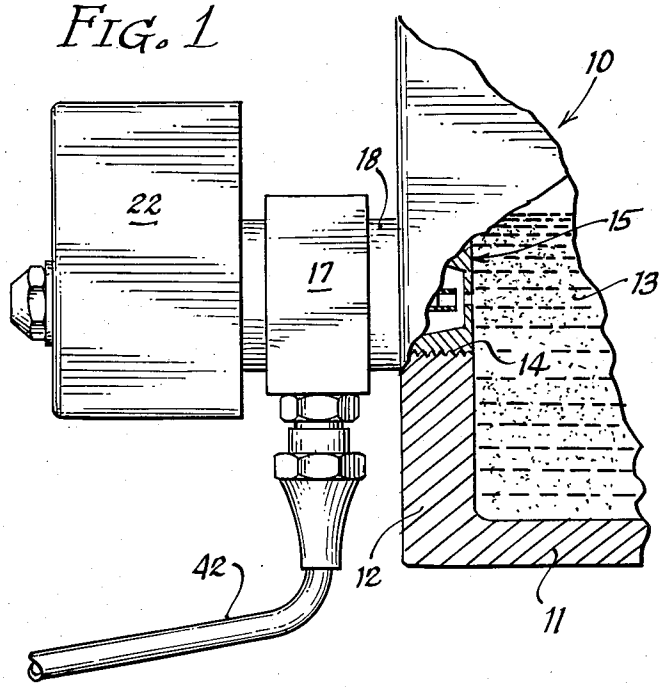
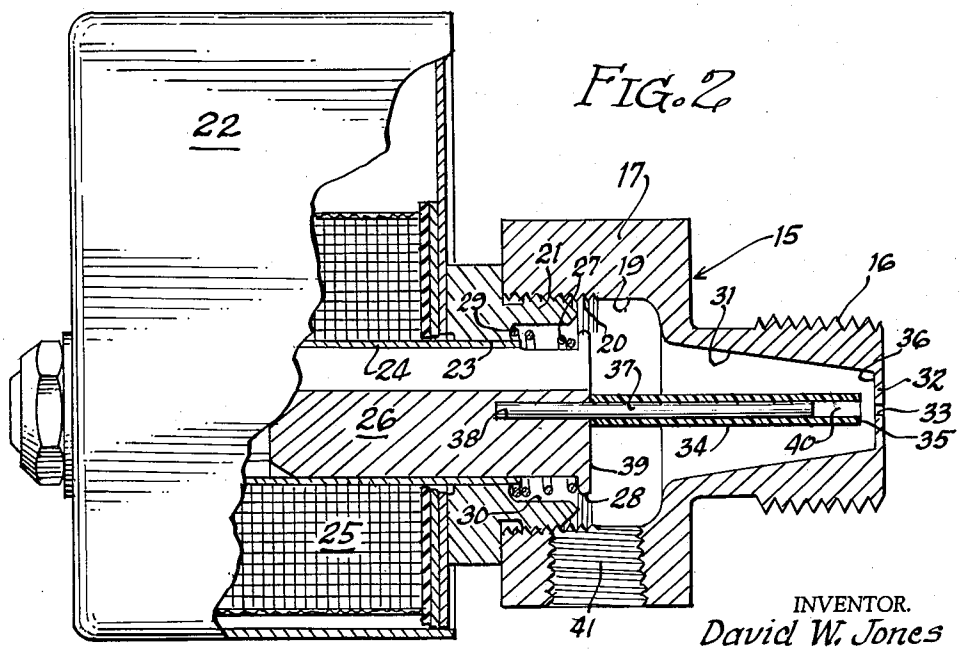


FIG. 2



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ORIFICE PLATE AND SOLENOID VALVE FOR GRITTY LIQUIDS

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4 Claims. (Cl. 137—242)

This invention relates to valve means for controlling the flow through an orifice of liquids having a gritty substance in powdered form suspended therein. For purposes of illustration this invention will be described with reference to its application to the control of the flow of lapping compound out of a container and into a pipe or upon a wire or the like which conducts the compound onto a lap. By "lapping compound" as used herein is meant a combination of a liquid vehicle and an abrasive in powdered form suspended in the vehicle.

Production lapping requires an automatic cycling of the lapping machine on which the lapping operation is performed so that all functions of the machine stop at the same time. Thus not only is the rotation of the lap plate automatically halted, but, to prevent an excessive accumulation of lapping compound on the plate, the flow of the compound must likewise be halted. It may be appreciated that the flow of the compound, even at its maximum allowable rate, is a mere trickle and hence the pressures developed in the stream are almost infinitesimal.

The lapping compound is usually stored in a container which is constantly agitated while the lapping machine is expected to be in use. The agitation is continued even while the lap is stopped and the work is unloaded and loaded so that there is a constant movement of the compound past the outlet from the container. It has been found that to insure a flow of the compound in quantities not exceeding the required trickle, the outlet from the container must be very small, on the order of a sixty-fourth of an inch in diameter. The small size of the outlet resulted in the formation of a small chamber in the outlet passage which was filled with the compound, but in which the agitation was not felt so that there was a tendency for the grit to settle out in the outlet passage and eventually block the passage of the compound to the lap. The settling tendency was counteracted to some extent by the pumping or jarring action produced by the periodic operation of the valve used to stop the flow of the compound at the end of a lapping cycle, but even this in time failed to prevent the clogging of the outlet.

It is accordingly among the principal objects of this invention to provide a means for controlling the flow of a liquid containing a powdered grit or the like in suspension from a container through an orifice or valve which will insure a continuous flow of the liquid and suspended grit from the container to the point at which the liquid is to be used.

A more specific object of this invention is the provision of a valve means for controlling the flow of a lapping compound through a relatively small orifice, said valve means being so constructed as to insure a continuous flow of the compound through the orifice when the valve is open and without any appreciable settling of the grit in the compound in the orifice.

A further specific object of this invention is the provision of an orifice plate through which lapping compound is to be conducted from a container to the point

at which it is to be used, said plate preferably being no thicker at the region immediately adjacent the orifice than the diameter of the orifice itself, such that there will be no appreciable reduction in the rate of flow of the compound through the orifice by virtue of friction developed between the compound and the walls of the orifice.

This invention also has within its purview the provision of a valve element for closing an orifice in a container of gritty liquids wherein said valve element is in the form of a tube of relatively chemically inert elastomeric material, with resilient means for urging the tube against the side of the container in which the orifice is formed in such manner as to have the tube surround the orifice and to be slightly deformed each time the spring is activated so that a pumping action is produced which assists in maintaining the orifice free of accumulated settled-out grit.

Other objects of this invention include the provision of a valve for controlling the flow of gritty liquids out of a container, said valve being electromagnetically operated to open position and spring operated to closed position, said valve including a threaded fitting having an orifice therein, said fitting supporting the electromagnetic actuating means such that the entire valve including the electromagnetic actuating means may be installed or removed as a unit.

These and other objects and features of this invention will become apparent from the following detailed description when taken together with the accompanying drawings in which,

Figure 1 is a side elevational view of the valve of this invention shown assembled with respect to a container for gritty liquids; and

Figure 2 is an enlarged sectional view through the valve to show the operative components thereof.

Referring now to Figure 1 for a detailed description of a preferred form of the invention there is shown at **10** a fragment of a container having a bottom wall **11** and a side wall **12**. Within the container is a liquid **13** in which is held in suspension a gritty substance such as a lapping grit or rouge. Since the grit in the liquid tends to settle out, means are provided (not shown) for continuously agitating the liquid. To make certain that all portions of the liquid are acted upon by the agitator, the container **10** may be of cylindrical form such that side wall **12** may be curved rather than flat. It is understood, however, that insofar as this invention is concerned the particular shape of the wall is immaterial. The grit and the liquid in which it is suspended are sometimes hereinafter referred to as a lapping compound.

Side wall **12** may have formed therein a threaded opening **14** into which is threaded a fitting **15** shown in greater detail in Figure 2. Said fitting has an externally threaded portion **16** which is threaded into opening **14** and an enlarged portion **17** disposed exteriorly of the wall **12**. A spacing washer **18**, which may be made of resilient deformable material such as rubber or the like, is disposed between the exterior surface of wall **12** and the enlarged portion **17**, not only to space the valve in predetermined relation to the interior surface of wall **12**, but also to act as a seal to prevent leakage of the compound around the threads of the threaded opening **14** to the exterior of the container.

Within enlarged portion **17** is formed a recess **19** which is threaded at **20** to receive the externally threaded attaching portion **21** of a solenoid housing **22**. Said attaching portion has an opening **23** therein through which extends a tube **24** which passes substantially through the winding **25** of the solenoid. Within tube **24** is an armature **26** which is normally located in a protruding position with respect to tube **24** by a spring **27** compressed between a flange **28** on armature **26** and the bottom **29**

of a counterbore 30 in attaching portion 21. Armature 26 is adapted to be drawn into the tube 24 (i.e. to the left as viewed in Fig. 2) by appropriate energization of winding 25.

The externally threaded portion 16 of fitting 15 has a recess 31 formed therein which is tapered to promote the flow of liquid therethrough under the influence of gravity when the axis of the recess is disposed substantially horizontally as shown in Fig. 2. Recess 31 extends to the right as viewed in Fig. 2 to such a degree as to leave a thin wall 32 through which is drilled or otherwise formed a small orifice 33. The diameter of orifice 33 is determined by the desired rate of flow of liquid out of container 10 and may be on the order of one sixty-fourth of an inch.

It has been found that when orifice 33 is as small as one sixty-fourth of an inch, and is long in proportion to its diameter, that the flow of liquid therethrough tends to decrease, thereby enhancing the tendency of the grid to settle out. This settling out tendency is unchecked, of course, when the orifice is closed and is further encouraged by any burrs which may be formed on the interior of the orifice by the drill used to form the orifice. It is desirable therefore to make orifice 33 as short as possible and preferably no longer than its diameter, as a result of which the thickness of wall 32 is made substantially equal to the diameter of orifice 33. Under these conditions, the build-up of grit in orifice 33 is limited and is readily broken up by the least difference in pressure on the two sides of wall 32.

Flow of compound through orifice 33 is controlled by a valve element in the form of a tube 34 of elastomeric material such as rubber or any of the synthetic rubber-like materials presently available. The inside diameter of tube 34 is preferably, though not necessarily, greater than the diameter of orifice 33, and the end surface 35 of tube 34 is made parallel to the inner surface 36 of wall 32 so that when tube 34 is held against wall 32, no liquid will flow therebetween.

Tube 34 is rigidly supported, preferably from its interior, by a pin 37 which is affixed to armature 26. In the form shown in Fig. 2, pin 37 is received with a press fit in an opening 38 in armature 26 and is movable therewith. The end surface 39 of armature 26 forms an abutment against which the left hand end (Fig. 2) of tube 34 bears and which determines the position of tube 34 on pin 37. It is contemplated that tube 34 has an interference fit with pin 37 such that tube 34 is slightly expanded as it is assembled over the pin and is held therefore against relative axial movement with reference to the pin by the frictional forces developed therebetween.

It may be observed that pin 37 terminates short or end surface 35 on tube 34. This creates a recess 40 which becomes enclosed by wall 32 (except for orifice 33) when the tube is held against said wall 32. It is contemplated that when armature 26 is pulled to the left as viewed in Fig. 2, by the energized coil 25, spring 27 will be compressed and will store up energy which will be suddenly released when winding 25 is de-energized. The sudden release of energy in spring 27 causes tube 34 to strike wall 32 sharply, thus compressing slightly the unsupported end of the tube and the air trapped in recess 40. The resulting increase in pressure of the air in recess 40 is felt in recess 33 and causes a reverse flow of liquid therein as well as a loosening of any grit that might be accumulated therein. A build-up of settled-out grit in the orifice 33 of sufficient magnitude to block the orifice is thus prevented. This loosening action is facilitated by the shortness of the orifice.

The compound flows out of orifice 33 and along the tapered side of recess 31 and then out through an opening 41 into a tube 42 or other means for conveying the compound to the lap (not shown) where it is used.

It has been found that an orifice and valve construction of the type described above provides a flow of compound out of a container even after long periods of cycling operation, i.e., periods during which the orfice is alternately opened and closed by the tube. When it is desired to repair or replace any part of the valve, the entire valve including the fitting 16 may be unscrewed as a unit from container wall 12, or alternatively solenoid 12 and its threaded attaching portion 21 may be removed separately.

I claim:

1. Apparatus for controlling trickle of a gritty liquid from a container having a thin wall over one region thereof and an orifice through the thin wall of a diameter substantially equal to the thickness of said thin wall, said apparatus comprising a tube of resilient material having an end region of a size adapted to encircle the orifice, a support for holding the tube adjacent the orifice, said support including means for closing the interior of the tube at a point removed from the orifice end of the tube, and means for shifting the support and tube from a position wherein the tube is held over the orifice to close said orifice to a position wherein the tube is held removed from the orifice to allow the gritty liquid to trickle out of the orifice.

2. Apparatus according to claim 1, said support for the tube comprising a pin of slightly greater diameter than the inside diameter of the tube extending into the tube and terminating short of the said end of the tube to provide flexibility for the said end of the tube.

3. Apparatus according to claim 1, said support for the tube comprising a pin extending into the tube and terminating short of the said end of the tube and said means for shifting the support and tube comprising a spring for urging the support toward the orifice, said spring compressing the said end of the tube against the wall, thereby compressing the air in the recess and in the orifice to assist in circulating gritty liquid through the orifice to clear the orifice of accumulated grit.

4. Apparatus for controlling a trickle of gritty liquid from a container having a relatively thick vertical wall near the bottom thereof, and having a threaded opening thereinto, said apparatus comprising a fitting having a threaded end adapted to be received in said container opening and having a recess within, and opening outwardly from, its said end to define a thin wall, an orifice in said thin wall of a size to produce a trickle of the gritty liquid through the thin wall, the axial length of the orifice being substantially equal to the diameter of the orifice to prevent a substantial accumulation of grit in the orifice, and means for closing the orifice comprising a tube of resilient deformable material, means supporting the tube from the fitting adjacent to and in substantial axial alignment with the orifice, the region of the tube adjacent the orifice being unsupported and closed to provide a cavity therein, and means for moving the tube rapidly against the said thin wall in encircling relation to the orifice, whereby to cause a compression of the air within said recess and a consequent pumping action of the liquid in the orifice to assist in dislodging and removing grit accumulated in the orifice.

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