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VACUUM FILLING APPARATUS

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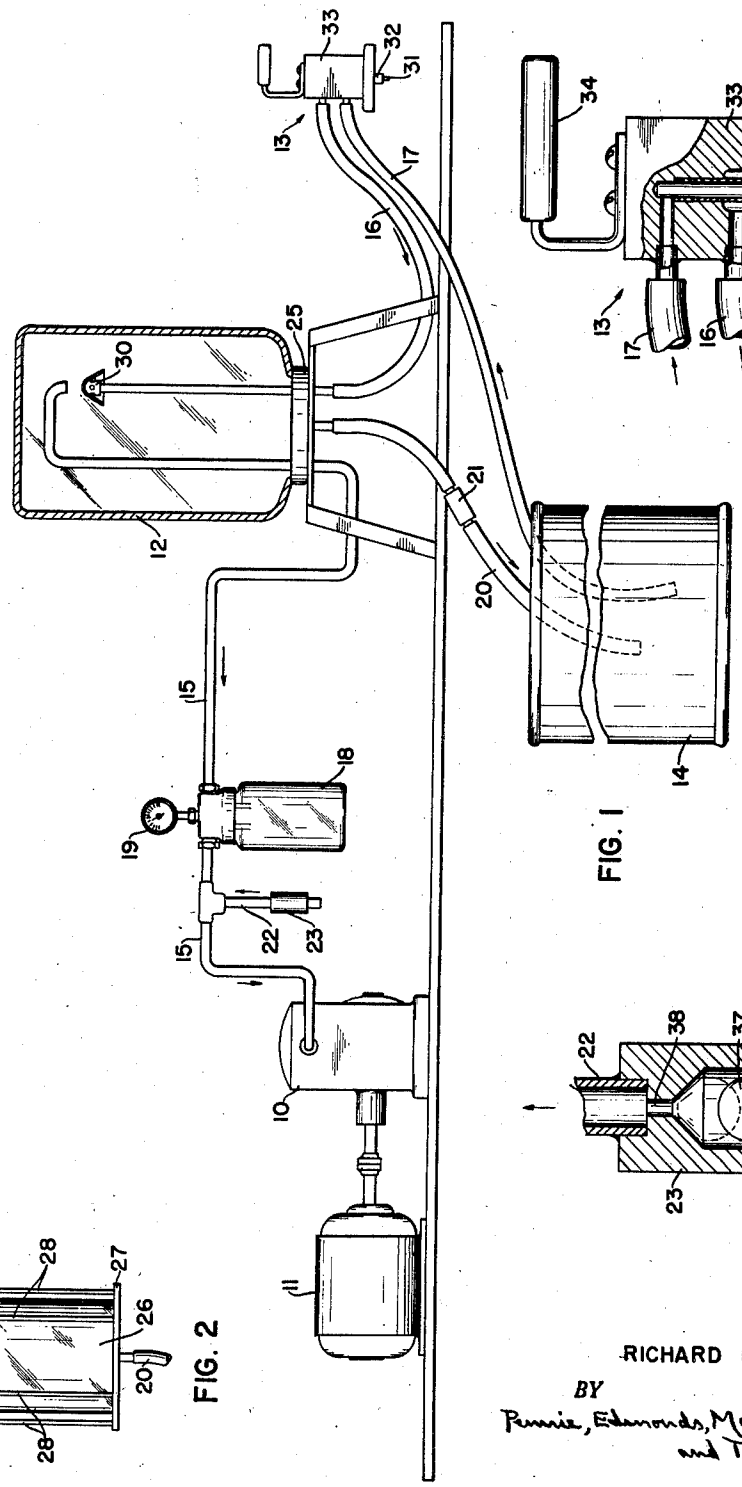


FIG. 1

FIG. 3

FIG. 2

FIG. 4

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VACUUM FILLING APPARATUS

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This invention relates to apparatus for filling bottles and similar containers with liquids.

A number of machines for filling bottles and similar containers with liquids have been devised. A type of machine that is widely used by the bottling industry for this purpose employs suction or vacuum to draw the liquid from a supply tank into the container being filled therewith. In essence, these vacuum filling machines comprise a motor driven vacuum pump, a filler spout adapted to be inserted into the neck of the container being filled, a supply reservoir for the liquid with which the container is being filled, a suction line connecting the vacuum pump to the filler spout, and a liquid supply line connecting the filled spout to the liquid supply reservoir. In the operation of such apparatus, the filler spout is placed in the neck of the container to be filled whereupon the vacuuum pump withdraws air from the container which is immediately replaced by liquid from the liquid supply reservoir. When the level of liquid in the container reaches the intake opening of the suction line, additional liquid entering the container is withdrawn therefrom through the suction line. To prevent damage to the vacuum pump due to liquid entering the suction line when the container is completely filled, a liquid overflow vessel is ordinarily provided in the suction line between the vacuum pump and the filler spout. Liquid drawn into the suction line from an overfilled container is collected in the overflow vessel and is accumulated therein in the course of the container filling operation. When the overflow vessel can accommodate no more liquid, the container filling operation must be interrupted in order to disconnect the overflow vessel from the suction line and empty the accumulated overflow liquid therefrom.

The interruption in the container filling operation in order to empty accumulated overflow liquid from the overflow vessel is a troublesome and uneconomical procedure. Various measures have heretofore been proposed for returning the overflow liquid accumulated in the overflow vessel to the liquid reservoir without interruption of the container filling cycle. Such measures have included the provision of a liquid pump to return accumulated overflow liquid to the liquid reservoir, of pairs of overflow vessels each of which is alternately incorporated in the suction line and then emptied of accumulated overflow liquid, and of manually operated or motor driven valve systems which in various ways provide for the return of overflow liquid to the liquid reservoir. The measures proposed in the prior art for returning overflow liquid to the liquid reservoir, however, have not proved altogether satisfactory for reasons that include an undue complexity of the mechanism, the need for manual manipulation by an operator to return the liquid to the liquid reservoir, or the need for interrupting the container filling cycle to perform some operation involved in the return of the liquid to the supply reservoir.

I have now devised an improvement in vacuum apparatus for filling containers which returns overflow

liquid from the overflow vessel to the supply reservoir completely automatically and without any need for interruption of the cyclic container filling operation. My vacuum container filling apparatus comprises a motor driven vacuum pump, an enclosed liquid overflow vessel, a liquid supply tank, a filler spout adapted to be inserted into the neck of the container to be filled, a first suction line connecting the vacuum pump to the overflow vessel, a second suction line connecting the overflow vessel to the filler spout, a liquid supply line connecting the filler spout to the liquid supply tank, a liquid overflow return line connecting the overflow vessel to the supply tank, a liquid check valve disposed in the overflow return line and adapted to prevent the flow of liquid from the supply tank to the overflow vessel, an air supply line connected to the first suction line intermediate the vacuum pump and the overflow vessel and an air check valve disposed in the air supply line. The air check valve is normally open and is adapted to remain open when the vacuum pump is in operation and the filler spout is exposed to the atmosphere (i. e., when not inserted into the neck of a container). However, the air check valve is adapted to close when the vacuum pump is in operation and the filler spout is inserted in the neck of a container to be filled. When the filter spout is inserted in the neck of a container to be filled with liquid, the air check valve and the liquid check valve close causing the suction created by the vacuum pump to draw liquid into the container. When the container is completely filled with liquid and the filler spout is removed from the neck thereof, the air check valve and the liquid check valve open and allow overflow liquid collected in the overflow vessel to return automatically to the liquid supply tank.

The vaccum filling apparatus embodying the automatic liquid overflow return feature of my invention may be used for small scale bottling operations such as are carried out by portable self-contained filling machines, or for large scale bottling operations such as are carried out in large commercial bottling plants. Irrespective of the specific embodiment of my invention, however, the operative principle underlying my apparatus will be clearly understood from the following description of the drawings of which

Fig. 1 is a view of an advantageous embodiment of the vacuum filling apparatus of my invention,

Fig. 2 is a view of an alternative form of main overflow vessel,

Fig. 3 is a section through a filling spout of suitable construction for use with my apparatus, and

Fig. 4 is a sectional view through an embodiment of the air check valve of my apparatus.

Vacuum apparatus for filling bottles and similar containers of the type to which my invention relates comprises a vacuum pump **10** operatively driven by an electric motor **11**, a main liquid overflow vessel **12**, a filler spout **13**, a liquid supply vessel **14**, a first suction line **15** connecting the intake of the vacuum pump **10** to the interior of the main overflow vessel **12**, a second suction line **16** connecting the interior of the main overflow vessel **12** to the filler spout **13**, and a liquid supply line **17** connecting the filler spout **13** to the liquid supply vessel **14**. A safety overflow vessel **18** disposed in the first suction line **15**, and a pressure gauge **19** adapted to indicate the internal pressure of the suction lines and the overflow vessels, are also advantageously provided. In the vacuum filling apparatus of my invention, there is further provided an overflow liquid return line **20** connecting the main overflow bottle **12** to the supply reservoir **14**, a liquid check valve **21** disposed in the overflow liquid return line **20**, an air supply line **22** connected to the suction line **15** between the vacuum pump **10** and the main overflow

vessel 12, and an air check valve 23 disposed in the air supply line 22.

The vacuum pump 10 is of conventional construction and has a capacity determined by the specific bottle filling operation in connection with which the apparatus is to be employed. The magnitude of the vacuum established by the vacuum pump 10 in the suction lines 15 and 16 and in the overflow vessels 12 and 18 is indicated by the pressure or vacuum gauge 19.

The intake of the vacuum pump 10 is connected to the filler spout 13 by means of the suction lines 15 and 16. The main overflow vessel 12 and the somewhat smaller safety overflow vessel 18 are connected to the suction lines 15 and 16 to trap and collect any overflow liquid that might be drawn into the suction lines by the action of the vacuum pump. The overflow vessels are airtight, advantageously transparent, containers provided with the necessary fittings for connecing the suction lines, pressure gauge 19 and liquid return line 20 thereto. For example, the overflow vessels may comprise the wide mouth glass bottles shown in Fig. 1 and having closure members 25 through which the suction and other fluid lines extend. Alternatively, the overflow vessels may comprise lengths of large diameter glass tubing 26 fitted with top and bottom closure plates 27 tied together with the rods 28, as shown in Fig. 2.

In order to trap the overflow liquid in the overflow vessels 12 and 18 and thus prevent it from entering the vacuum pump 10, the suction lines 15 and 16 communicate with the interior of each of the overflow vessels adjacent the top thereof. When the suction lines 15 and 16 enter an overflow vessel through the bottom thereof, as is the case with overflow vessel 12 shown in Fig. 1, the suction lines extend upwardly within the vessel to within a short distance of the top thereof. When the suction lines enter the overflow vessel through the top thereof, as is the case with overflow vessel 12 shown in Fig. 2, the suction lines terminate within a short distance of the top of the vessel. In either case it is desirable to provide the discharge end of the suction line 16 with a baffle member 30 to direct overflow liquid downwardly and away from the intake end of the suction line 15. Of course, as shown in Fig. 1 and Fig. 2, the overflow liquid return line 20 communicates with the interior of the main overflow vessel 12 adjacent the bottom thereof.

The filler spout 13 is adapted to be inserted into the neck of a container to be filled with liquid and, when thus inserted, to fill the container with liquid to a predetermined level. It comprises a liquid supply pipe 31 and a suction pipe 32 that are advantageously concentrically mounted in a suitable support member 33 having a handle 34, as shown best in Fig. 3. The liquid supply pipe 31 and the suction pipe 32 are connected by means of the liquid supply line 17 and the suction line 16 to the liquid supply reservoir 14 and the overflow vessel 12, respectively. A gasket member 35 is mounted on the support member 33 a short distance above the open ends of the liquid supply pipe 31 and suction pipe 32 and is adapted to bear against the neck of a container being filled with liquid to provide an air-tight seal between the filler spout 13 and the container. When the filler spout 13 is positioned over a container to be filled with liquid so that the gasket member 35 bears firmly against the neck of the container, the liquid supply pipe 31 and the suction pipe 32 extend downwardly a short distance into the container. Liquid drawn into the container by the action of the vacuum pump rapidly fills the container up to the level of the intake of the suction pipe 32. Excess liquid drawn into the container is withdrawn therefrom through the suction line 16 and is collected in the main overflow vessel 12. The filler spout shown in Fig. 3 is adapted to fill only one container at a time and is provided with a handle for manual manipulation of the filler spout in the course of the container filling operation. The filler spout, of course, can be adapted to fill more than one container

at a time by the provision of a plurality of pairs of liquid supply and suction pipes. Moreover, the filler spout can readily be adapted for use in large scale bottling plant operations by providing appropriate mechanical means for inserting the filler spout into an empty container to be filled and for withdrawing the filler spout from the container when it becomes filled.

As noted hereinabove, the filler spout 13 is connected to the liquid supply reservoir 14 by the liquid supply line 17. Moreover, to permit the overflow liquid collected in the main overflow vessel 12 to return to the supply reservoir 14, the overflow vessel 12 is connected to the supply reservoir by the liquid return line 20. To control the flow of liquid through the liquid return line 20, the liquid check valve 21 is provided. The liquid check valve is of conventional construction, advantageously a ball check valve, and is adapted to allow the flow of liquid through the return line 20 from the main overflow vessel 12 to the supply reservoir 14, and to prevent the flow of liquid through the liquid return line 20 in the opposite direction.

Although the liquid return line 20 and the check valve 21 are provided as described, I have found that the overflow liquid collected in the main overflow vessel 12 will not return to the supply reservoir 14 through the return line 20 unless the pressure in the overflow vessel 12 is allowed to rise to substantially atmospheric so that the difference in pressure between the interior of the overflow vessel 12 and the atmosphere will be less than that equivalent to the head of liquid in the vessel 12 and the return line 20. Accordingly, I provide the air supply line 22 and the air check valve 23 which automatically vent the suction line 15 and vacuum pump 10 to the atmosphere when the filler spout 13 is removed from the neck of a container being filled with liquid, thereby allowing the reduced pressure within the overflow vessel 12 to approach atmospheric and the overflow liquid in the vessel 12 to flow through the liquid return line 20 to the supply reservoir 14.

The air check valve 23 of my apparatus, which advantageously is a modified ball valve such as that shown in Fig. 4 of the drawing, is normally open and is adapted to remain open until the difference in pressure between the valve intake (communicating with the atmosphere) and the valve discharge (communicating with the suction line 15) reaches a predetermined value. The pressure differential required to close the valve 23 must be such that, when the vacuum pump is in operation, the valve will remain open as long as the suction pipe 32 of the filler spout 13 has free access to the atmosphere, and will close when free access of air to the suction pipe 32 is substantially curtailed as by the insertion of the filler spout into the neck of an airtight container to be filled with liquid. As a consequence, when the filler spout 13 is not inserted in the neck of a container air will be drawn by the vacuum pump into the suction line 15 through the suction pipe 32 and the air supply line 22, and when the filler spout is inserted in the neck of a container the only air drawn into the suction line 15 will be that withdrawn from the container being filled with liquid. Moreover, the air-handling capacity of the air check valve 23 must be such that when the valve is open air in sufficient quantity to substantially completely satisfy the maximum air intake requirements of the pump can be supplied through the filler spout 13 and the air supply line 22. With the maximum air requirements of the pump thus satisfied, the pressure in the main overflow vessel 12 will remain close to atmospheric and, therefore, any overflow liquid in the vessel 12 will flow freely through the liquid return line 20 to the supply reservoir 14.

Conventional air check valves, which are designed to permit the flow of air through the valve in one direction and to prevent the flow of air through the valve in the opposite direction, would not be satisfactory for use in my apparatus. When the vacuum pump is in operation the pressure differential between the inside of the suc-

tion line 15 and the atmosphere tends to cause air to flow through the air supply line 22 and, therefore, would tend to maintain a conventional air check valve in its closed position. To adapt such an air check valve for use in my apparatus, it is necessary to modify the valve so that it is maintained normally open and will not close until the difference in pressure across the valve reaches a predetermined value. This result can be attained in a number of ways, as, for example, by providing a spring member tending to maintain the valve closure member (i. e. the ball of a ball check valve) in its open position, by increasing the mass of the valve closure member, or by restricting the free flow of air through the valve. The kind and extent of the modifications effected depend upon the type of air check employed and the specific vacuum filling apparatus of which it is a part.

With a ball valve of the type shown in Fig. 4, I have found that the valve can most readily be adapted for use in my apparatus by increasing the mass of the ball closure member 37 and by restricting the flow of air through the valve with a restricted aperture 38. The specific characteristics of the air check valve must be determined experimentally for each vacuum filling apparatus in connection with which it is to be used. For example, with vacuum filling apparatus employing a vacuum pump having a displacement of about 3.5 cubic feet per minute and capable of establishing and maintaining a vacuum of about 28 inches of mercury in a closed system, I have found that an air check valve provided with a stainless steel ball closure member 37 having a diameter of a half inch and an aperture 38 having a diameter of one-eighth inch performs as required in my apparatus.

In the operation of my apparatus, the motor driven vacuum pump 10 is first started up, thereby creating a suction in suction line 15. Air enters the suction line 15 through the suction pipe 32 and the air supply line 22 in sufficient quantity to substantially completely supply the maximum air intake requirements of the vacuum pump so that the pressure within the main overflow vessel 12 remains at approximately that of atmospheric. For example, at this point in the operation of a typical vacuum filling apparatus of my invention, the internal pressure in the main overflow vessel 12, as indicated by the vacuum gauge 19, is about one-half inch of mercury. When the filler spout 13 is inserted in the neck of a container to be filled with liquid the pressure in the suction line 15 and overflow vessel 12 drops rapidly due to the severe restriction in the supply of air available to the vacuum pump through the filler pipe 32. When the vacuum gauge 19 indicates an internal pressure of about 3 inches of mercury, the volume and velocity of the air being drawn into the suction pipe 15 through the air supply line 22 becomes sufficient to overcome the resistance to closure of the valve closure member 37, whereupon the air check valve 23 closes shutting off all further supply of air to the vacuum pump except through the suction pipe 32. The pressure within the vacuum apparatus continues to drop rapidly, reaching 15–20 inches of Hg in a few seconds, while at the same time liquid is drawn by the reduced pressure into the container being filled therewith. When the container becomes filled with liquid to the level of the intake end of the suction pipe 32 therein, excess liquid is withdrawn from the container through the suction line 16 to the overflow vessel 12.

The appearance of overflow liquid in the overflow vessel indicates that the container is filled to the desired level, whereupon the filler spout 13 is removed from the container thereby exposing the suction pipe 32 to the atmosphere. With air freely entering the open end of the suction pipe 32, the pressure within the vacuum apparatus rises rapidly. When the internal pressure of the vacuum apparatus has risen to about 3 inches of Hg, as indicated by the vacuum gauge 19, the air check valve opens allowing air to enter the suction line 15 through the air supply line 22. Once again the pressure within the main overflow vessel 12 approaches that of atmospheric, thereby allowing the overflow liquid collected in the overflow vessel 12 to flow through the overflow return line 20 to the liquid supply reservoir 14. Because of the substantially atmospheric pressure prevailing within the overflow vessel 12, the overflow liquid is returned to the supply reservoir very rapidly, an average amount comprising, say, about a pint of liquid being returned to the liquid supply reservoir in less time than it takes the operator of the apparatus to remove the filler spout 13 from the neck of a full container and to insert the filler spout into the neck of an empty container. The action of the air check valve 23, closing and opening when the filler spout is inserted in and is removed from the neck of a container, is completely automatic thus providing a simple and dependable mechanism by means of which liquid overflow is automatically returned to the liquid supply reservoir in the period of time required for the transfer of the filler spout from one container to another.

I have found that vacuum filling apparatus lacking the automatic air vent and liquid return features of my invention requires either frequent interruption of the container filling operation or elaborate mechanical expedients to return liquid overflow to the liquid supply reservoir, whereas this function is performed in my apparatus completely automatically by a simple and dependable mechanism. Accordingly, it will be seen that I have devised a valuable contribution to the art to which my invention relates.

I claim:

1. Vacuum filling apparatus for bottles and similar containers comprising a motor driven vacuum pump, an enclosed liquid overflow vessel, a liquid supply reservoir, a filler spout adapted to be inserted in the neck of a container to be filled with liquid, a first suction line connected to the intake of the vacuum pump and communicating with the interior of the overflow vessel adjacent the top thereof, a second suction line connected to the filler spout and communicating with the interior of the overflow vessel adjacent the top thereof, a liquid supply line connecting the filler spout to the liquid supply reservoir, a liquid overflow return line connected to the liquid supply reservoir and communicating with the interior of the overflow vessel adjacent the bottom thereof, a liquid check valve disposed in the overflow return line to check the flow of liquid from the supply reservoir to the overflow vessel, an air supply line connected to the first suction line intermediate the vacuum pump and the overflow vessel, and a normally open pressure actuated air check valve disposed in said air supply line, said air check valve being adapted to close automatically when the difference in pressure between the first suction line and the atmosphere reaches a predetermined value, said predetermined pressure difference being greater than that which exists across the air check valve when the filler spout is exposed to the atmosphere and being less than that which exists across the air check valve when the filler spout is inserted in the neck of a container.

2. In vacuum filling apparatus for bottles and similar containers comprising a motor driven vacuum pump, an enclosed liquid overflow vessel, a liquid supply reservoir, a filler spout adapted to be inserted into the neck of a container to be filled with liquid, a first suction line connecting the vacuum pump to the overflow vessel, a second suction line connecting the overflow vessel to the filler spout, said first and second suction lines communicating with the interior of the overflow vessel adjacent the top thereof, and a liquid supply line connecting the filler spout to the liquid supply reservoir, the improvement which comprises a liquid overflow return line connecting the overflow vessel to the supply reservoir, said liquid overflow return line communicating with the interior of the overflow vessel adjacent the bottom thereof, a liquid check valve disposed in the liquid overflow re-

turn line to prevent the flow of liquid from the supply reservoir to the overflow bottle, an air supply line connected to the first suction line intermediate the vacuum pump and the overflow vessel, and a normally open pressure actuated air check valve disposed in said air supply line, said air check valve being adapted to close automatically when the difference in pressure between the first suction line and the atmosphere reaches a predetermined value, said predetermined pressure difference exceeding that which exists across the valve when the filler

spout is exposed to the atmosphere and being exceeded by that which exists across the air check valve when the vacuum pump is in operation and the filler spout is inserted in the neck of a container in sealed relation thereto.

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