PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Apparatus for the Automatic Filling of Vessels

We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V., a Company organised under the Laws of the Netherlands, of 30 Carel van Bylandtlaen, The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an apparatus for the automatic filling of vessels with a liquid supplied through a filling line adapted to be coupled successively to the vessels. Apparatus of this type is used, for example, for filling metal bottles with liquid petroleum gas such as propane and butane.

The difficulty attendant on filling bottles with liquid petroleum gas is that only slight deviations are permissible from the stipulated quantity of liquid to be put in the bottle. In particular, a bottle must not be filled to excess since when the temperature is high the bottle would then become nearly or entirely filled with liquid and burst.

The problem is not solved by filling the bottles to a certain gross weight as there is too much difference in the weights of the empty bottles. Moreover, since they are often not quite empty, they cannot be immediately filled with a specific weight or volume of liquid, and consequently the bottles first have to be treated to remove any liquid left in them. Although it gives good results this method is cumbersome and relatively expensive.

The object of the invention is to provide an apparatus for the high-speed filling of bottles and other vessels in such a way that the quantity of liquid in the filled vessel remains within the permissible limits without first having to remove any liquid remaining in the vessel.

To this end apparatus for the automatic filling of a vessel according to one aspect of the present invention in which a liquid is supplied through a filling line adapted to be coupled to the vessel includes a source of radiation and two radiation detectors which are associated therewith and arranged at different levels, each of the detectors being arranged to produce a signal dependent on the intensity of radiation received, the source and the two detectors being arranged on opposite sides of the space provided for the vessel, the signal from the lower detector being arranged to cause the flow of liquid in the filling line to be substantially reduced and the signal from the upper detector being arranged to cause such flow of liquid to stop.

Conveniently the signals are arranged to operate separate valves in the filling line, one comprising a main valve closed by the first signal and the second a subsidiary valve closed by the second signal and supplied by a restricted passage by-passing the first valve.

According to a specific aspect of the present invention an apparatus for the automatic filling of vessels with a liquid supplied through a filling line adapted to be coupled successively to the vessels includes a source of penetrating radiation together with two radiation detectors which are associated therewith and arranged at different levels, each of which detectors gives an electric signal dependent on the intensity of the radiation received, the source and detectors being arranged on either side of the space provided for a vessel to be filled, the signal from the lower detector controlling a first valve capable of substantially but not completely shutting off the filling line and the signal from the upper detector being capable of closing a second valve in the filling line, the setting being such that when the liquid level in the vessel rises the first valve is first closed, and the second valve is closed afterwards, the filling line being shut off completely when the first valve and the second valve are closed.

Preferably the signal from the upper detector is capable of breaking the coupling be-

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tween the filling line and the vessel after closing the second valve, the second valve being arranged in a filler head at the end of the filling line. The filler head may be provided with a spring-loaded movable inner part arranged to reciprocate in an outer part, the bottom of the inner part being capable of coupling to the filling connection of a vessel, and the inner part consisting of upper and lower tubular portions each having at least one opening extending through it to an annular space between the parts, the lower portion being of a smaller outside diameter than the inner part, and the tubular parts being separated by a partition and an external stop formed by the said difference in the outside diameters of the tubular portions, the stop being arranged to be forced by the spring against a sealing ring such that the stop and ring form the second valve and prevent flow from one tubular part to the other.

The invention will now be further illustrated with reference to the drawing, wherein:

Figure 1 is a diagram of an apparatus according to the invention, and

Figure 2 is a longitudinal section of the filler head designated by 11 in Figure 1, with the valve in the open position.

Referring to Figure 1, a bottle 1 is shown which is being filled with a liquid, e.g. butane or propane, in a suitable space 2. The bottle 1 is provided at its top with a connection 3 having a flat upper surface and a valve (not shown). Different liquid levels in the bottle are respectively designated by A, B and C.

The liquid is supplied through a filling line 4, which is provided with a line section 5 with a remote-controlled valve 6, a by-pass 7 with a throttle 8, a line section 9 of variable length, a line section 10, and a filler head 11. Secured to the line section 10 is a piston 12 which is adapted to move in a stationary cylinder 13, so that the line section 10 and the filler head 11 may be moved up and down.

The filler head 11, as shown in Figure 2, consists of an upper part 14 with a central bore 15, a lower part 16 with a central bore 17, an inner part 18 composed of a number of elements, a spring 19 and a number of sealing rings: 20, 21, 22, 23, 24 and 25. The upper part 14 may be connected by means of a screw thread 26 to the line section 10 and by means of a screw thread 27 to the lower part 16.

The inner part 18 fits into the bores 15 and 17, movement of the part 18 is limited both at the top and bottom by stops. The spring 19 tends to move the inner part 18 downward relatively to the upper part 14.

The inner part 18 consists of an upper tubular portion 28 and a lower tubular portion 29 with a partition 30. The spring 19 rests in the upper tubular portion 28 and bears at its lower end on the partition 30. Lateral openings 31 are provided in the wall of the upper tubular portion 28 near the partition 30 and inclined openings 32 extend through the wall of the lower tubular portion 29 into a central bore therein which extends to the bottom of the filler head. The outside diameter of the upper tubular portion 28 is greater than that of the lower tubular portion 29, a stop 33 thus being formed by the underside of the partition 30 between the openings 31 and 32. This stop 33, in conjunction with the sealing ring 22, forms a valve which can be shut by the spring 19. The communication between the openings 31 and 32 is then broken, so that no liquid can flow through the filling line 4.

The under surface 34 of the sealing ring 25 is capable of making a sealing engagement against the flat upper surface of the connection 3 of the bottle 1. When the filler head 11 and the bottle 1 are moved towards each other, by moving either the line section 10 downwards or the bottle 1 upwards, first the under surface 34 of the sealing ring 25 and the upper surface of the connection 3 come in contact with each other, ensuring a leakproof coupling, and then the inner part 18 moves upward relatively to the upper part 14 to the position shown in Figure 2, the valve 22/33 being opened so that communication is established between the openings 31 and 32 and liquid can flow through the filling line 4 to the bottle 1. When the bottle 1 and the line section 10 are moved away from each other the valve 22/33 first shuts by the action of the spring 19, after which the coupling between the filler head 11 and the bottle 1 is broken.

Now that the construction and operation of the filler head 11 have been explained, reference is again made to Figure 1. A source 36 of penetrating radiation, e.g. neutron radiation, and two radiation detectors 37 and 38 which are associated therewith are arranged on opposite sides of the bottle 1. The detector 37 is arranged above the detector 38 at such a level that the line Z between the source 36 and the detector 37 intersects the level C which corresponds to the desired liquid level of the filled bottle.

The detectors 37 and 38 give an electric signal preferably by means of adjustable amplifiers (not shown) the power of which signal depends on the intensity of the radiation received and hence also on the level of the liquid in the bottle. The signal from the detector 38 is passed via a line 39 to a three-way solenoid valve 40 which is capable of connecting a line 41 for operating the valve 6 either to a line 42 for compressed instrument air or to the atmosphere. In the position shown the coil of the three-way valve 40 is excited, the lines 41 and 42 are connected and the valve 6 is open.

When the coil of the three-way valve 40 is

not excited the three-way valve 40 moves to the other position, thus reducing the pressure in the line 41 and closing the valve 6.

The signal from the detector 37 is passed via line 43 to a three-way solenoid valve 44 which is capable of connecting a line 45 for operating a four-way pneumatic valve 46 either to the line 42 for compressed instrument air or to the atmosphere.

The four-way valve 46 controls the piston-cylinder combination 12/13. In the position shown, in which the valve 44 is excited, the line 45 communicates with the atmosphere and compressed working air is passed from a line 47 to a line 48 which issues above the piston 12 in the cylinder 13. A line 49 which issues below the piston 12 in the cylinder 13 communicates with the atmosphere via the four-way valve 46.

When the valve 44 is no longer excited it is reversed and instrument air flows from the line 42 via the line 45 to the four-way valve 46. The latter is thereby reversed so that the working air flows from line 47 to line 49 and the air in the space above the piston 12 can escape to the atmosphere via the line 48 and the four-way valve 46. The piston 12 is thereby moved upward and the coupling between the filler head 11 and the bottle 1 is broken.

A roller operated three-way valve 50 is connected to the four-way valve 46 by a line 51 for subsequently returning the four-way valve 46 to the position shown. In the position shown air from the line 51 can flow away through the three-way valve 50 to the atmosphere, but when the roller of the three-way valve 50 is operated instrument air flows from line 42 to line 51 and the four-way valve 46 is brought into the position shown, the piston 12 being forced downwards and the filler head 11 coupled to the next bottle 1.

A number of the apparatuses shown may advantageously be arranged on a turn table (not shown) with a central supply of liquid, instrument air, working air and electricity. The empty bottles are then introduced into one of the filling apparatuses at a given position and removed again before the turn table has described a complete turn. A catch can be provided at a fixed point so as to operate the rollers of the three-way valves 50 shortly after a bottle is placed in the correct position on the turn table.

The apparatuses operate as follows :

1. When, in operation, a full bottle 1 has been removed from the position 2 the radiation received by the detectors 37 and 38 is at its maximum; as a result the coils of the three-way solenoid valves 40 and 44 are excited, the valve 6 open and the piston 12 in the upper position.

2. A bottle 1 to be filled is then placed at the position 2.

3. The roller operated three-way valve 50 is then operated, thus reversing the four-way valve 46 and forcing the piston 12 downward so that the filler head 11 is coupled to the connection 3 of the bottle 1 and the valve 33/22 is opened.

4. Liquid, e.g. butane, then flows through the filling line 4 to the bottle in which the liquid level rises. Owing to the presence of the downwardly spurting liquid the intensity of the radiation received by the detectors 37 and 38 at this stage is lower than in the earlier stages, but this has no effect on the position of the valves, and when the surface of the liquid reaches the level A the valves are still in the same position.

5. However, before the level reaches B the surface of the liquid comes into the path of the radiation to the detector 38 and the intensity of the radiation received by this detector, as will be explained below, gradually decreases to a lesser or greater degree until finally a minimum is reached when the radiation received traverses the liquid throughout its path. The setting is, however, such that before this happens the valve 40 is reversed and the valve 6 closed.

6. The liquid can then only flow to the bottle through the line section 7 provided with the throttle 8 and, thereby considerably reducing the filling rate. The liquid level in the bottle rises with gradually decreasing intensity of the radiation received by the detector 37 until, when the level C is reached, the valve 44 is reversed causing the piston 12 to rise and hence first the valve 33/22 closes and then the coupling between the filler head 11 and the bottle 1 is broken.

7. When the bottle is removed at the end of its travel the detectors 37 and 38 again receive radiation at maximum strength so that the three-way valves 40 and 44 are again reversed and the valve 6 is again opened. Reversing the valve 44 has no immediate effect, although it permits subsequent reversal of the four-way valve 46 (see stage 3).

The apparatus is so set as to minimize the time required for filling a bottle without loss of accuracy. Hence there is a maximum rate of filling in the final filling phase (stage 6). The bottle should therefore be filled as far as possible via the valve 6 (stage 4). But the high filling rate in this stage (4) precludes a high degree of accuracy since the liquid surface is violently agitated by the liquid injected. This causes a variation in the extent to which the bottle is filled at the moment the valve 6 closes. The setting should now be such that under no circumstances is the bottle too full before the supply via the valve 6 is cut off. The higher the filling rate in stage (4) the greater will be the possible deviation and the longer the topping-up (stage 6). The filling rate in stage 4 should therefore not be too high. It is moreover recommended to design the filling opening of the bottle and

the valve provided therein in such a way that the liquid flows into the bottle as regularly as possible. The nearer the optimum setting is approached the greater can be the speed of the turn table and hence the production.

It will be understood that the invention is not limited to the apparatus shown in the drawing. Thus, for example, it is not necessary to operate the apparatus pneumatically and electrically as it may also be operated hydraulically or electrically.

It is not essential to couple the bottle 1 to the filler head 11 by moving downward the line section 9; the bottle 1 may alternatively be moved upward until a stop for the bottle is reached. This is particularly attractive when the bottles have a better finish at the top than at the bottom because the filling level is then coupled to the top of the bottle.

Nor is it essential to use a line section 7 parallel to the line section 5. It is, for instance, also possible to provide a small opening in the closing member of the valve 6 so that even when the valve is closed a certain quantity can still flow along the filling line. The one essential provision in this connection is that there should be a valve which is capable of ~~substanially~~ substantially although not entirely shutting off the filling line.

It is desirable that the level of the radiation source 36 and the detectors 37 and 38 may be easily altered so that the apparatus may be used for bottles of different sizes. For the same reason it is also advisable so to design the apparatus that both filling rates can be altered in a simple manner.

The necessary provisions should, of course also be taken to ensure that the radiation from the source 36 has no harmful effect on the operators and that safety is also observed in other respects.

WHAT WE CLAIM IS:—

1. An apparatus for the automatic filling of a vessel with a liquid supplied through a filling line adapted to be coupled to the vessel including a source of radiation and two radiation detectors which are associated therewith and arranged at different levels, each of the detectors being arranged to produce a signal dependent on the intensity of radiation received, the source and the two detectors being arranged on opposite sides of the space provided for the vessel, the signal from the lower detector being arranged to cause the flow of liquid in the filling line to be substantially reduced and the signal from the upper detector being arranged to cause such flow of liquid to stop.

2. Apparatus as claimed in Claim 1 in which the signals are arranged to operate separate valves in the filling line, one comprising a main valve closed by the first signal and the second a subsidiary valve closed by the second signal and supplied by a restricted passage bypassing the first valve.

3. An apparatus for the automatic filling of vessels with a liquid supplied through a filling line adapted to be coupled successively to the vessels including a source of penetrating radiation together with two radiation detectors which are associated therewith and arranged at different levels, each of which de~~ectors~~ tectors gives an electric signal dependent on the intensity of the radiation received, the source and detectors being arranged on either side of the space provided for a vessel to be filled, the signal from the lower detector controlling a first valve capable of substantially but not completely shutting off the filling line, and the signal from the upper detector being capable of closing a second valve in the filling line, the setting being such that when the liquid level in the vessel rises the first valve is first closed, and the second valve is closed afterwards, the filling line being shut off completely when the first valve and the second valve are closed.

4. Apparatus as claimed in claim 2 or claim 3 in which the signal from the upper detector is capable of breaking the coupling between the filling line and the vessel after closing the second valve, the second valve being arranged in a filler head at the end of the filling line.

5. Apparatus as claimed in Claim 4 in which the filler head is provided with a spring loaded movable inner part arranged to reciprocate in an outer part, the bottom of the inner part being capable of coupling to the filling connection of a vessel, and the inner part consisting of upper and lower tubular portions each having at least one opening extending through it to an annular space between the parts, the lower portion being of a smaller outside diameter than the ~~iner~~ inner part, and the tubular parts being separated by a partition and an external stop formed by the said difference in the outside diameters of the tubular portions, the stop being arranged to be forced by the spring against a sealing ring such that the stop and ring form the second valve and prevent flow from one tubular part to the other.

6. Apparatus for the automatic filling of vessels substantially as described herein and illustrated in the accompanying drawings.

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2. Apparatus as claimed in Claim 1 in which the signals are arranged to operate separate valves in the filling line, one comprising a main valve closed by the first signal and the second a subsidiary valve closed by the second signal and supplied by a restricted passage bypassing the first valve.

3. An apparatus for the automatic filling of vessels with a liquid supplied through a filling line adapted to be coupled successively to the vessels including a source of penetrating radiation together with two radiation detectors which are associated therewith and arranged at different levels, each of which de~~ecters~~ tectors gives an electric signal dependent on the intensity of the radiation received, the source and detectors being arranged on either side of the space provided for a vessel to be filled, the signal from the lower detector controlling a first valve capable of substantially but not completely shutting off the filling line, and the signal from the upper detector being capable of closing a second valve in the filling line, the setting being such that when the liquid level in the vessel rises the first valve is first closed, and the second valve is closed afterwards, the filling line being shut off completely when the first valve and the second valve are closed.

4. Apparatus as claimed in claim 2 or claim 3 in which the signal from the upper detector is capable of breaking the coupling between the filling line and the vessel after closing the second valve, the second valve being arranged in a filler head at the end of the filling line.

5. Apparatus as claimed in Claim 4 in which the filler head is provided with a spring loaded movable inner part arranged to reciprocate in an outer part, the bottom of the inner part being capable of coupling to the filling connection of a vessel, and the inner part consisting of upper and lower tubular portions each having at least one opening extending through it to an annular space between the parts, the lower portion being of a smaller outside diameter than the ~~iner~~ inner part, and the tubular parts being separated by a partition and an external stop formed by the said difference in the outside diameters of the tubular portions, the stop being arranged to be forced by the spring against a sealing ring such that the stop and ring form the second valve and prevent flow from one tubular part to the other.

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