Oct. 27, 1970 R. SCHMIDT 3,536,925

APPARATUS AND METHOD FOR FILLING A CONTAINER WITH LIQUID

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Fig. 1.

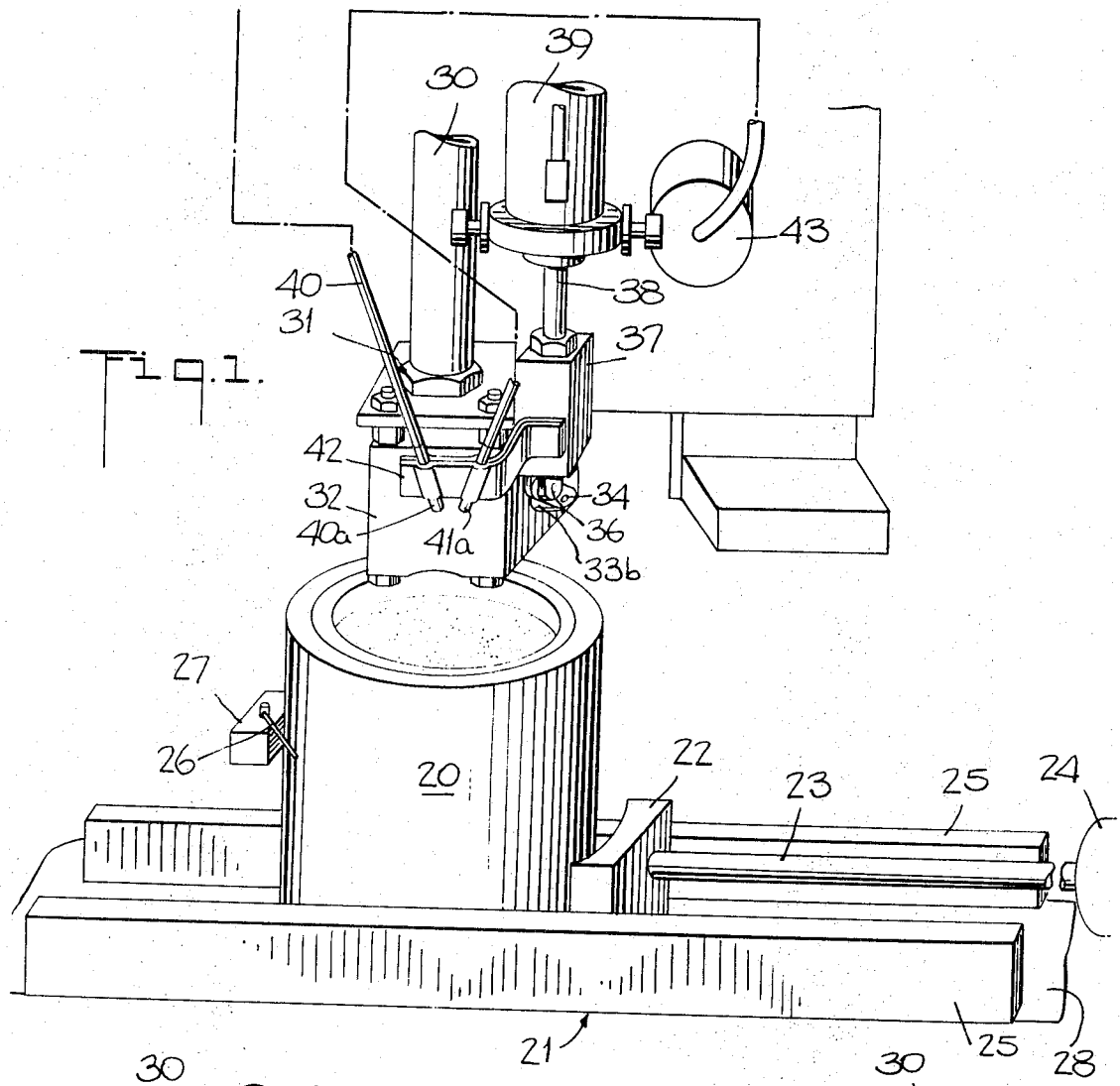


Fig. 5.

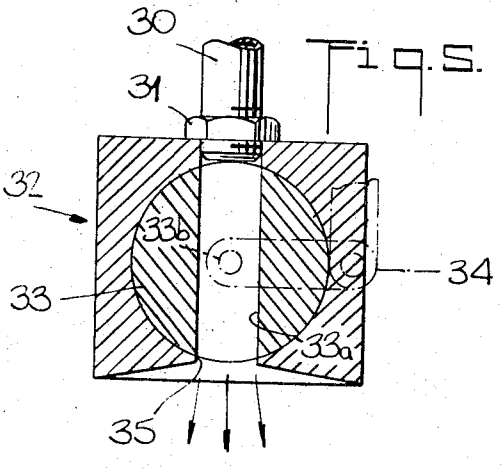
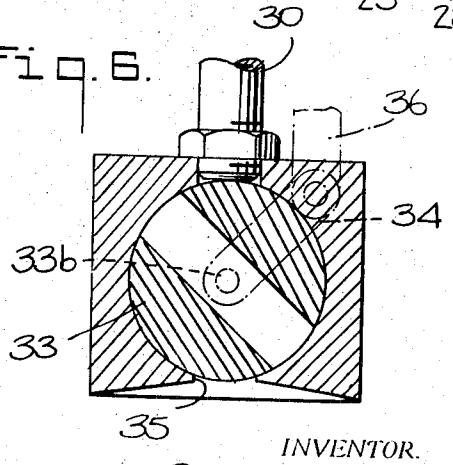


Fig. 6.



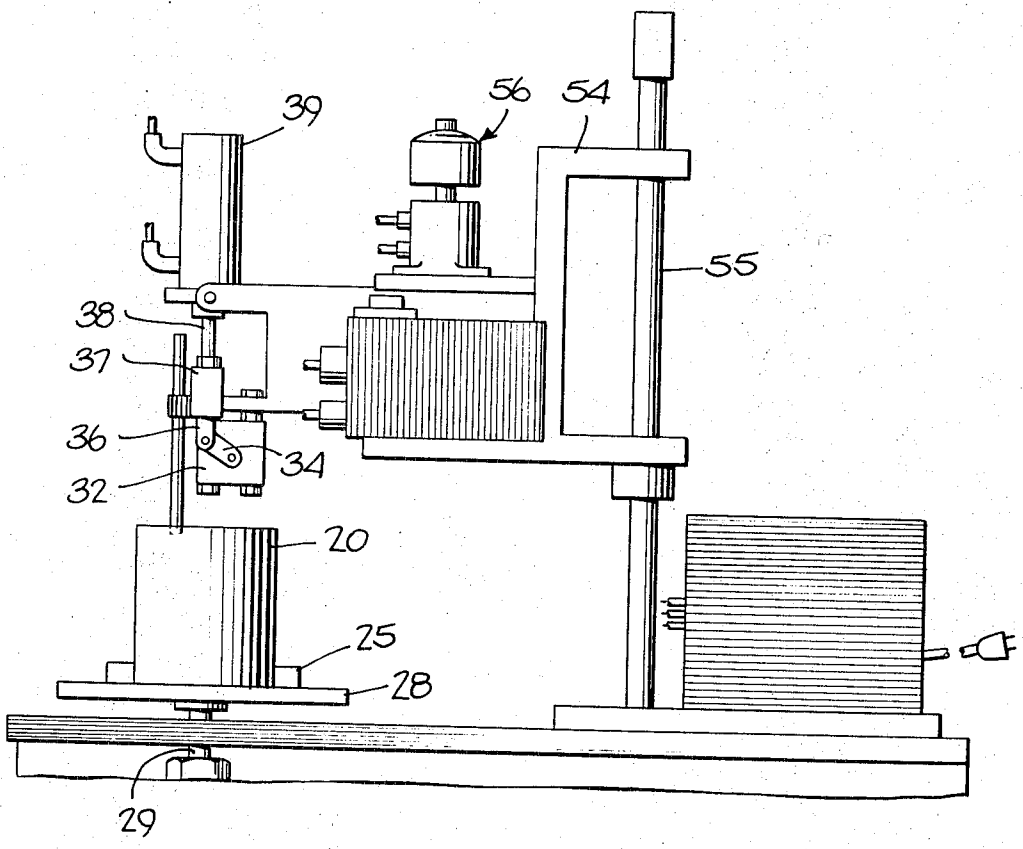
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APPARATUS AND METHOD FOR FILLING A CONTAINER WITH LIQUID

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Fig. 2.



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APPARATUS AND METHOD FOR FILLING A CONTAINER WITH LIQUID

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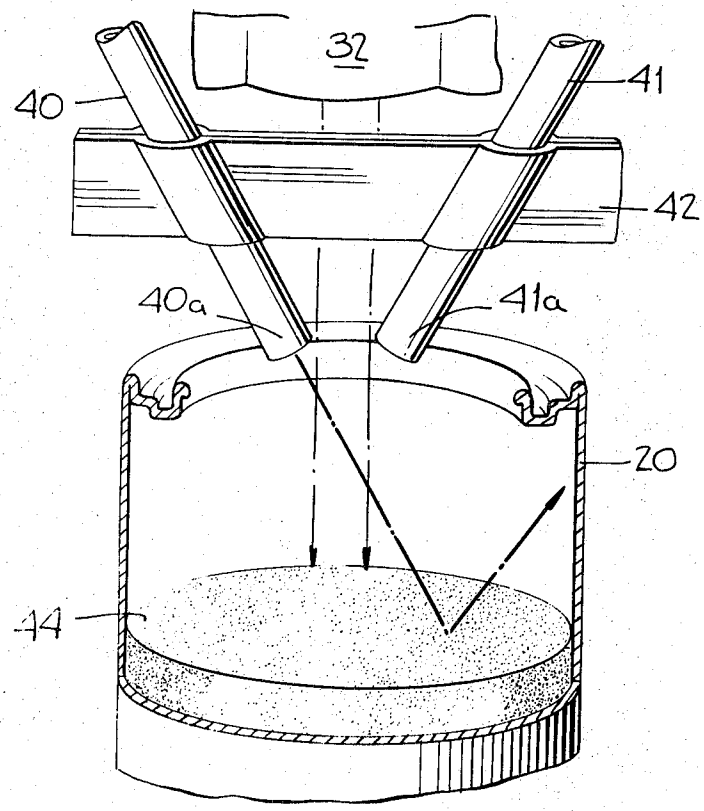


Fig. 3.

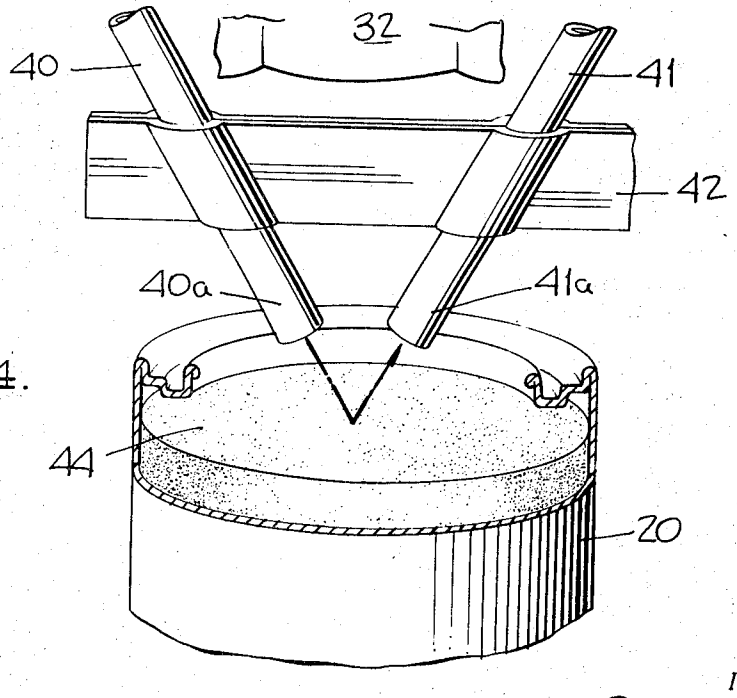


Fig. 4.

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APPARATUS AND METHOD FOR FILLING A CONTAINER WITH LIQUID

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Fig. 7.

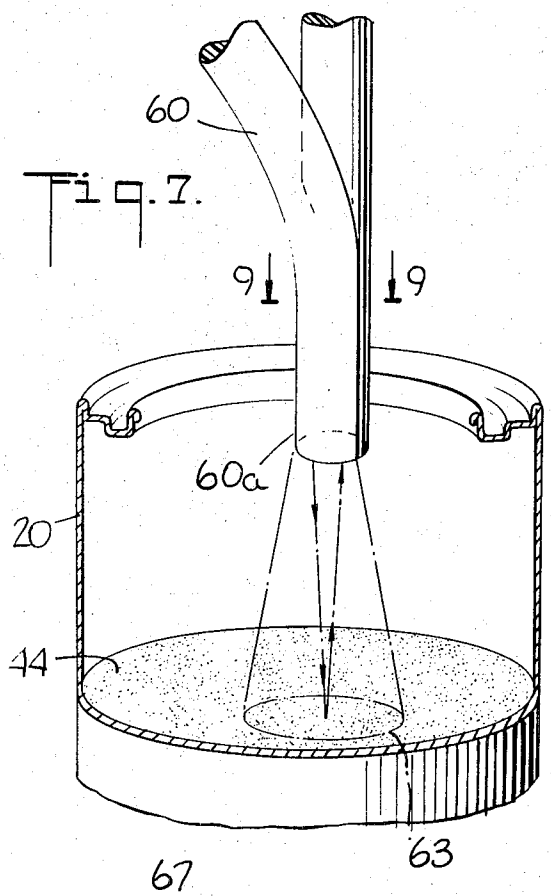


Fig. 8.

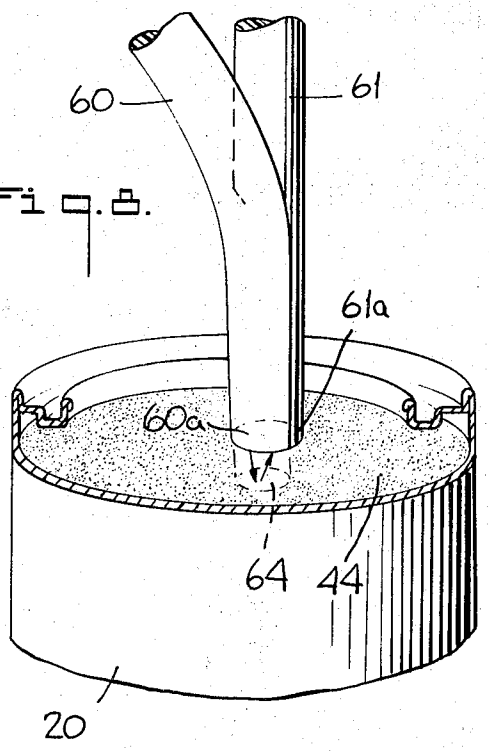


Fig. 9.

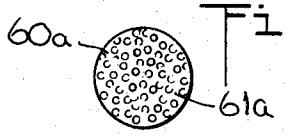


Fig. 10.

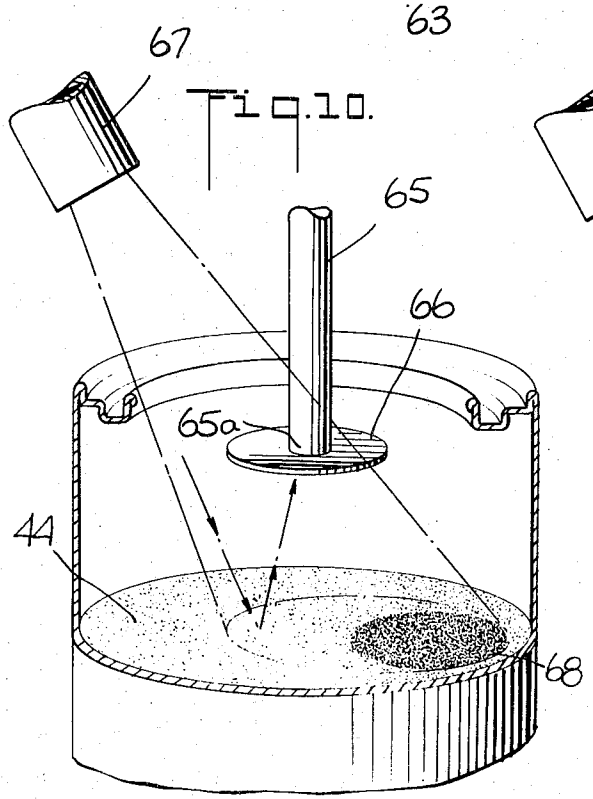
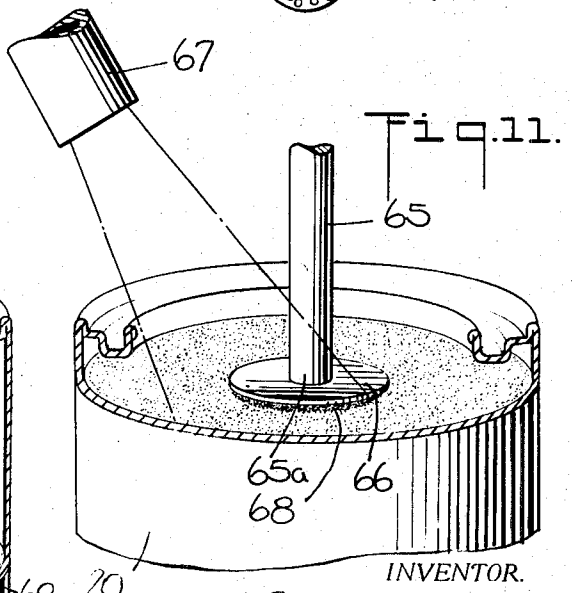


Fig. 11.



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APPARATUS AND METHOD FOR FILLING A CONTAINER WITH LIQUID

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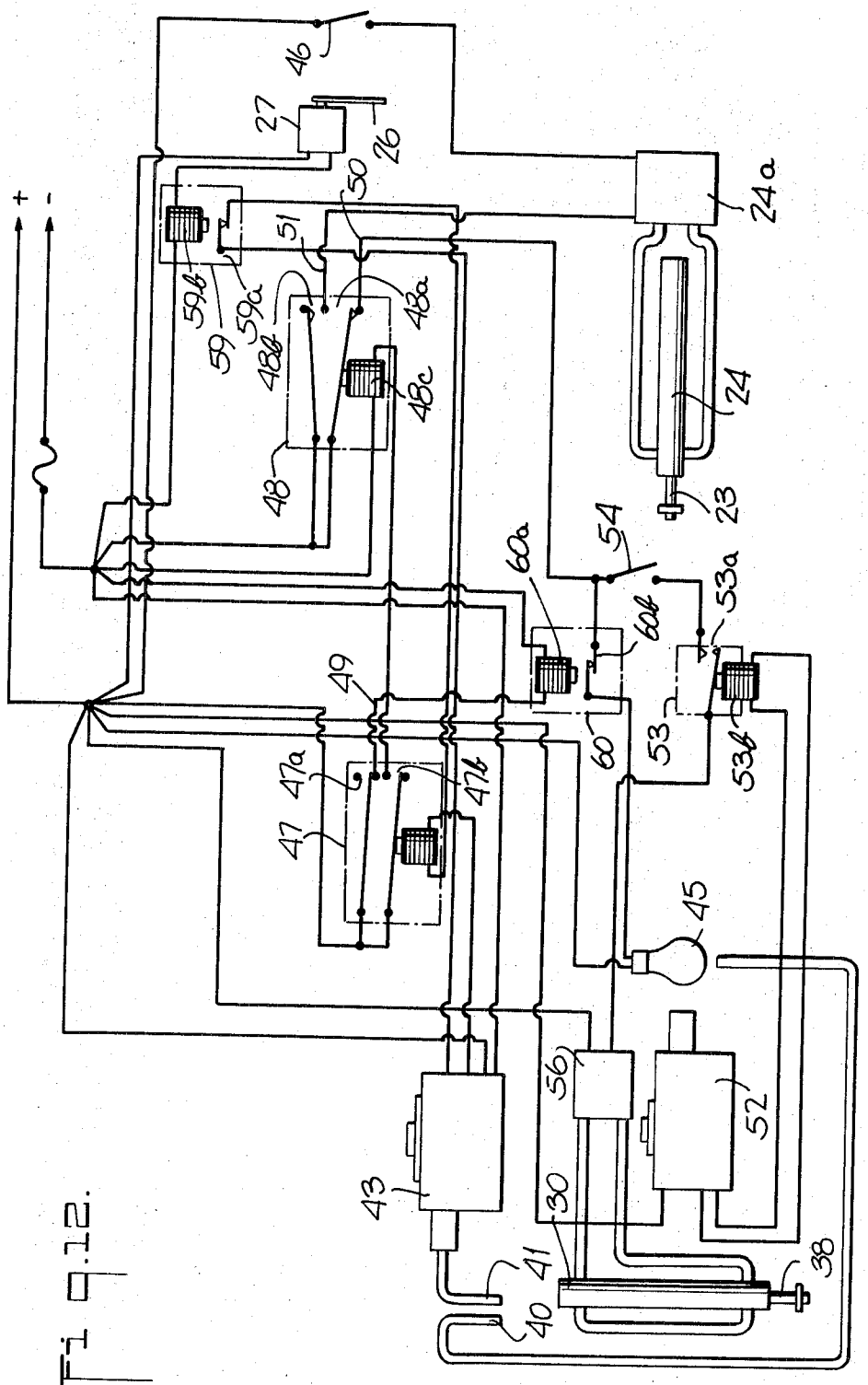


Fig. 12.

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United States Patent Office 3,536,925 Patented Oct. 27, 1970

3,536,925

APPARATUS AND METHOD FOR FILLING A CONTAINER WITH LIQUID

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Filed June 2, 1967, Ser. No. 643,220
Int. Cl. B67d 5/372; G01h 21/26
U.S. Cl. 250—218 19 Claims

ABSTRACT OF THE DISCLOSURE

The disclosure of the invention relates to a method and apparatus for establishing a predetermined level of material in a receptacle.

In accordance with the invention, radiant energy is directed toward the interior of the receptacle which is to receive the material. When the material is delivered to the receptacle, the radiant energy is reflected from the surface of the material. Means are provided which respond to at least a portion of the radiant energy reflected from the surface of the material within the receptacle when the material is at the predetermined level within the receptacle in order to sense the presence of a predetermined level. Means are also provided for terminating the delivery of the material to the receptacle in response to the sensing of the presence of the predetermined level.

In the preferred embodiment set forth herein, the invention is used to control the uniform filling of cans with liquid by directing light toward the rising surface of the liquid. The light is reflected from the surface of the liquid. When the surface of the liquid has reached a predetermined level, the response of a photoelectric cell to the light reflected from the surface of the liquid in the receptacle causes the flow of liquid to be terminated.

BACKGROUND OF THE INVENTION

The field of the invention is the control of the flow of a liquid into a receptacle or container in order to establish a predetermined level and thereby a predetermined volume of liquid in the container. More particularly, the field of the invention is the uniform filling of cans with a liquid such as paint.

Of the various prior art methods of filling containers with a predetermined quantity of liquid, two methods are most commonly used. One method is to measure the liquid in a separate step by means of a chamber which can hold the desired quantity of liquid. This premeasured quantity of liquid is then transferred by a second step to the container. This method requires two steps, necessitates the use of additional equipment, can readily result in wasted liquid, long cleanup, complicates maintenance due to the measuring chamber, and requires an extensive cleaning procedure after operation or whenever there is a change in the material being measured.

Another method of the prior art is to weight the container and the liquid as the container is being filled. When a total weight of the desired quantity of liquid plus the weight of the empty container is reached, the total weight indicates that the container is filled. In this method slight inaccuracies in the weighing equipment can cause large errors in the quantity being measured. Weighing also becomes a difficult method when relatively small quantities are to be measured.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an accurate measurement of the quantity of liquid in a container by sensing the level of the surface of the liquid in the container.

It is a further object of the present invention to incorporate the accurate measurement of the quantity of liquid in a container into a control system for a device for automatically filling containers to a predetermined level.

In accordance with the invention radiant energy is reflected from the surface of the liquid as the liquid is delivered into the container. At the desired level of liquid in the container, the reflected radiant energy senses the level and causes the filling operation to terminate.

Further in accordance with the invention, the sensing by reflected radiant energy of the filling of one container causes the next container to be advanced for filling.

In summary, radiant energy is directed toward the surface of liquid being delivered to a container. As the container is filled, the surface of the liquid reflects the radiated energy. As the surface of the liquid rises to a predetermined level within the container, the reflected radiant energy is sensed and the sensing means terminates the filling cycle. In this way a predetermined level and thereby a predetermined quantity of liquid is established in the container.

In the preferred embodiment set forth herein, the invention is used to control paint flow into containers. The radiant energy source selected is a light source located either directly above the container or connected to an optical fiber whose other end is located above the container. As the paint fills the container the light is reflected from the rising surface of the paint. At the predetermined level the light reflected from the surface and transmitted by another optical fiber to a photoelectric cell is sufficient to activate the cell and thereby control the termination of the filling cycle. By the proper positioning of this latter optical fiber, the light intensity transmitted to the photoelectric cell is sufficient to activate the photoelectric cell when the paint reaches the predetermined level within the container.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned objects and features of the invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view of the system of the invention for advancing and filling containers with a predetermined level of liquid;

FIG. 2 is a side elevational view of the embodiment of the invention shown in FIG. 1;

FIG. 3 is a fragmentary perspective view showing optical fibers extending to adjacent the interior of a container for transmitting light toward the surface of material within the container and for receiving reflected light from the surface;

FIG. 4 is a fragmentary perspective view related to that of FIG. 3 and showing the transmitted and reflected light at the predetermined level of the liquid surface within the container;

FIG. 5 is a vertical sectional view of the ball valve for delivering the liquid with the ball valve shown in its open or flow position;

FIG. 6 is a vertical section view of the ball valve in its closed or cutoff position;

FIG. 7 is a fragmentary perspective view of an additional embodiment of optical fibers for directing light toward the surface of material and for transmitting light reflected from the surface when the container is partially filled;

FIG. 8 is a fragmentary persepective view of the embodiment of FIG. 7 and showing light being reflected from the surface of the liquid when the predetermined level is reached;

FIG. 9 is a horizontal section view of the optical fiber shown in FIG. 7;

FIG. 10 is a fragmentary perspective view showing light being directed toward the surface of the liquid and past a mask surrounding the aperture of an optical fiber, the mask forming a relatively diffused shadow on the liquid surface;

FIG. 11 is a fragmentary prespective view related to that of FIG. 10 and showing the intense shadow formed on the liquid surface by the mask;

FIG. 12 is a wiring diagram of the apparatus of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment of the present invention is in an automatic system for filling paint cans. While the following description is directed to this, it is to be understood that it is merely for illustration and is not intended to preclude the use of the invention in any other device.

Briefly, the preferred embodiment acts as follows: A pusher is advanced by an actuator to move a can along a channel and under the paint filling device. Thereupon optical fibers for directing light toward the surface and for transmitting light reflected from the surface at the predetermined level are lowered to a position adjacent to the interior of the container. The flow of paint into the container is then initiated. When the paint surface has reached a predetermined level within the interior of the container, the path of the light reflected from the surface is in substantial alignment with the optical fiber for transmitting reflected light. The reflected light transmitted by the optical fiber activates a photoelectric cell. The activation of the photoelectric cell causes the paint flow to be shut off and the optical fibers to be elevated from the immediate proximity of the container. The pusher is then again advanced to push the filled can along the channel and out from under the device and at the same time to move an empty can to the filling station. The device can then be recycled and the filling process repeated.

The system for establishing a predetermined level of material in a receptacle in accordance with the invention is shown in FIG. 1. In the embodiment of FIG. 1 the apparatus is adapted to fill receptacles or containers such as paint cans **20** with material such as paint. The cans are advanced to filling station **21** by means of pusher **22** connected to piston rod **23** of actuator **24**. Can **20** is advanced by pusher **22** between guide rails **25** of the filling station. When the can is positioned at the filling station it engages arm **26** of switch **27** and causes the switch to close.

As shown in FIG. 2, cans **20** travel along platform **28** which is supported by one or more of screws **29**. By adjustment of screw **29** the vertical position of platform **28** can be determined. In turn the level at which cans **20** travel is established with respect to the remainder of the filling apparatus of the invention.

The paint to be delivered to the can is supplied by line **30** connected to inlet **31** of valve **32** which can be a ball valve (FIG. 1). As shown in FIGS. 5 and 6, valve **32** contains ball **33** having passage **33***a*. By means of shaft **33***b* connected to the ball and arm **34** connected to the shaft, the ball can be rotated between open and closed positions. In FIG. 5, the passage of the ball is shown in alignment with discharge opening **35** of the valve while in FIG. 6 the ball is shown in the closed position. In order to prevent the dripping of liquid from the valve when the ball is moved to the closed position, the axial length of the discharge opening beyond the lower portion of the ball is maintained at a minimum dimension. As a result the annular surface of the discharge opening has a minimum area which can be coated with paint. In this way a dribble of the valve after closing is completely eliminated.

The ball valve is operated by link **36** which is connected to coupling **37** (FIG. 1). The coupling is attached to piston rod **38** of actuator **39**. Thus upon reciprocating the piston rod, ball **33** can be rotated by the motion transmitted to it through arm **34**.

The system for establishing a predetermined level of material or paint in the receptacle or can **20** includes means for directing radiant energy toward the interior of the can such as optical fiber **40** having end portion **40***a* exposed to the interior of the can. The opposite end portion of optical fiber **40** is exposed to a source of radiant energy such as a lamp (not shown). Adjacent to end portion **40***a* of optical fiber **40** there is disposed end portion **41***a* of additional optical fiber **41**. Both of the end portions are supported by bracket **42** which is mounted upon coupling **37**. Optical fiber **41** is connected to a photoelectric device such as photocell **43**.

Since the optical fibers are mounted with respect to coupling **37**, the end portions of the optical fibers are moved in a vertical direction whenever actuator **39** is operated to open or close ball valve **32**. Thus when ball valve **32** is opened, the ends of the fiber optics are lowered to adjacent the opening of can **20** as shown in FIG. 3. Since the ends are positioned closely adjacent to one another, the ends can be lowered into the opening of the can.

With the fiber optics extending into the can the liquid such as paint **44** is delivered to the can from ball valve **32** (FIG. 3). The light directed from fiber optic **40** is a substantially concentrated beam which strikes the surface of the rising level of paint and is reflected toward the inner surface of the can. As shown in FIG. 4, when the surface of paint **44** has reached the predetermined level to which the container is to be filled, the beam of light from optical fiber **40**, upon being reflected from the surface of the paint, enters into the end portion **41***a* of optical fiber **41**.

In this way it can be seen that the vertical position of the ends of the optical fibers with respect to the predetermined level of the paint, the angle between the optical fibers and the spacing between the end portions of the optical fibers determine the exact level of the surface of the paint at which the reflected light can enter optical fiber **41**. Thus it is possible by the positioning of the optical fibers with respect to the surface of the paint to determine in a precise manner the level of paint which causes the reflected light to enter optical fiber **41**. At all other levels of the surface of the paint, the reflected beam of light substantially passes away from optical fiber **41**.

At the predetermined level of the surface of the paint within the container **20**, the light reflected into optical fiber **41** activates photocell **43** which in turn terminates the filling cycle of valve **32**. Thus by means of actuator **39** the ball valve is closed and at the same time the end portions of the optical fibers are elevated free of the opening in the can. At this point pusher **22** can be operated against an incoming empty can disposed adjacent to the filled can at the filling station so that the filled can is advanced beyond the filling apparatus and the empty can is positioned in the filling station.

The ball valve and the optical fiber are supported with respect to platform **28** by frame **54** mounted on standard **55**. When the size of the can is changed, corresponding changes can be made in the rest position of the optical fibers and valve **32** by adjusting the relative position of platform **28** by screw **29**. As a result, a large range of different sizes of containers can be accurately filled.

The wiring diagram of the embodiment of the invention shown in FIGS. 1 and 2 is shown in FIG. 12. At the beginning of the cycle of operation of the apparatus, an empty can is disposed at the filling station under ball valve **32** and the next empty can to be filled is adjacent to the can at the filling station. The can at the filling station engages and closes switch **27** by contacting switch arm **26**. The moment switch **27** is closed and switch **54**

is closed by the operator, the following condition exists:

(a) Photocell **43** is energized because it is not receiving light since lamp **45** is extinguished;

(b) Relay **47** is energized by photocell **43**.

(c) Relay **48** is inactive (neutral-pusher circuit closed) by the energizing of relay **47**.

When switch **46** is closed by the operator, pusher circuit **51** is completed through electric air control valve **24***a* and piston rod **23** extends from cylinder **24**. As piston rod **23** extends, it pushes the second empty can under ball valve **32** which in turn pushes the first can from under ball valve **32**. As the first empty can is pushed from under ball valve **32**, the can releases arm **26** and causes switch **27** to open. Opening switch **27** deactivates time delay relay **59** and causes the relay to recycle. When switch **27** is again closed by the second empty can intersecting arm **26**, switch **27** starts the time delay at contact **59***a*. Since time delay relay contact **59***a* is normally closed, the operation of the delay opens the feeder circuit to relay **47** for the duration of the delay.

When the second can is under ball valve **32** and engages switch arm **26**, thereby closing switch **27**, contact **59***a* is opened and thereby breaks the feeder circuit to relay **47**. At the moment contact **59***a* on time delay relay **59** opens, the following conditions exist:

(a) Photocell **43** is energized because it is not receiving light since lamp **45** is extinguished;

(b) Relay **47** is de-energized by the open circuit through time delay relay **59**;

(c) Relay **48** is energized (filler-circuit closed) by the de-energizing of **47**.

The opening and closing of the above relays at this point completes the filler circuit to lamp **45** at contact **48***a*. Lamp **45** is lighted and de-activates photocell **52** which in turn activates relay **53** thereby completing the circuit to electric-air control valve **56**. Piston rod **38** is driven down and opens ball valve **32** to start the flow of paint into can **20**. At this time, pusher piston rod **23** withdraws pusher **22** toward cylinder **24**. An empty can is then placed adjacent to the can being filled.

When time delay relay **59** once more closes the feeder circuit at contact **59***a* to relay **47** the following conditions exist:

(a) Photocell **43** is energized even though light is transmitted through optical fiber **40**, since the optical fiber is not transmitting reflected light to photocell **43**;

(b) Relay **47** is energized by photocell **43**;

(c) Time delay relay **60** (normally closed) is energized by the closing of circuit at **47***a* on relay **47**. Relay **60** then starts the timing operation and opens the circuit to lamp **45** if can **20** is not filled by the time lamp **45** is turned off by the normal filling method. If bulb **45** goes out by this method, photocell **52** is activated, thereby opening the filling circuit at relay **53**. The filling head is retracted and the machine shuts down. Thus there is provided a safety device so that if any malfunction occurs in the circuit, an excessive quantity of paint will not be delivered to can **20**.

(d) Relay **48** is inactive (neutral-filler circuit closed) in response to the energizing of **47**.

When the level of paint delivered to can **20** reaches the predetermined level, light from lamp **45** which is transmitted through optical fiber **40** is reflected from the surface of the liquid into optical fiber **41**, thereby deactivating photocell **43** momentarily. At this moment the following condition exists:

(a) Photocell **43** is de-activated.

(b) Relay **47** is de-activated by electric eye **43**.

(c) Relay **48** is activated by the de-activating of relay **47** (pusher circuits closed).

Because of the break in the filler circuit at **48***a* on relay **48**, lamp **45** is turned off. Photocell **52** is activated and opens the filler circuit not only at **48***a* but at **53***a* as well. This double opening of the filler circuit de-energizes the electric air control valve **56** causing piston rod **38** to be withdrawn upwardly and thereby shutting off the flow of paint through ball valve **32**. As valve **32** shuts off the flow of paint, piston rod **23** extends with respect to cylinder **24** since the pusher circuit is completed and activates electric air control valve **24***a*. The extending piston rod serves to advance the next empty can under ball valve **32**.

As piston rod **38** withdraws upwardly, optical fibers **40** and **41** are withdrawn from the filled can of paint (lamp **45** is extinguished). The following conditions then exist:

(a) Photocell **43** (not receiving light through optical fiber **41**) is energized;

(b) Relay **47** is energized by photocell **43**;

(c) Relay **48** is inactive (neutral-pusher circuit closed) in response to the energizing of **47**.

While piston rod **23** pushes an empty can under ball valve **32** the previously filled can which is advanced by the empty can releases arm **26** of switch **27**, thereby momentarily opening switch **27**. Opening switch **27** deactivates time delay relay **59** and causes it to recycle so that when switch **27** is closed again by the advancing empty can, switch **27** will start the time delay at **59***a* once more. Since time delay relay **59** is a normal-closed switch, the operation of the time delay relay opens the feeder circuit to relay **47** for the duration of the delay. At this point ball valve **32** is opened and delivers paint into empty can **20**. Another empty can is placed adjacent to the can being filled and the cycle of operation begins again. It should be noted that relay **48** is a ratchet impulse relay which alternates the opening and closing of filler circuit **50** and pusher circuit **51**. Thus when the filler circuit is opened the pusher circuit is closed and vice versa. It should also be noted that due to the ratchet action of relay **48**, activated) and two different "closed" conditions (relay activated). For example, if circuit **50** is in a "neutral" condition the relay is not active and circuit **50** is complete. An electric impulse to relay **48** at **48***c* will throw the contacts of relay **48** to a "closed" position thereby breaking circuit **50** and contacting circuit **51**. When the electric impulse is terminated again to relay **48** at **48***c*, circuit **51** will be in a "neutral" position and circuit **51** is still closed. Activating relay at **48***c* again moves the contacts to a "closed" position, thereby breaking circuit **51** and contacting circuit **50**. When relay **48** is again deactivated, circuit **50** goes into a "neutral" condition with circuit **50** still closed.

If the source of light, lamp **45** should fail, an overfilling condition could occur since the rising level of paint could not be sensed by reflected light. By means of relay **53** in the filling circuit of the apparatus, the apparatus will be shut down by the opening of the contacts of relay **53** in response to the failure of photocell **52** to receive light from lamp **45**.

Upon failure to provide an empty container adjacent to the container being filled, the operation of the apparatus terminates upon the filling of the container at the filling station.

As shown in FIG. 7, optical fiber **60** directs light from its end portion **60***a* toward the surface of paint **44** in can **20**. The light reflected from the surface enters end portion **61***a* of optical fiber **61** which leads to a photocell device (not shown). End portions **60***a* and **61***a* which have been lowered into the opening of can **20** as shown in FIGS. 7 and 8 are intermeshed with respect to each other, so that at their termination as shown in FIG. 9, the filaments making up each of optical fibers **60** and **61** are dispersed evenly throughout the cross section. The nature of the optical fibers prevents light from being transmitted from the lengths of the optical fibers of one end portion to the other in the manner of cross-talk.

As shown in FIG. 8, when the surface of paint **44** has reached a predetermined level within can **20**, the pattern **63** of light projected onto the surface of the paint of FIG. 7 is reduced to a small but intense pattern **64**, shown in FIG. 8. As a result, the increased intensity of the light pattern on the surface of the paint in FIG. 8 is sufficient to actuate the photocell (not shown) connected to optical

fiber **61**. Thus it can be seen that the arrangement of FIGS. 7 and 8 for sensing the presence of the surface of the paint at the predetermined level within the can is determined by the intensity of the reflected light as opposed to the orientation of the beam of the reflected light in the manner shown in FIGS. 3 and 4.

In the embodiment of the invention shown in FIGS. 10 and 11, optical fiber **65** which has been lowered into the opening of can **20** transmits light reflected from the surface of paint **44** to a photocell (not shown). Adjacent to and surrounding the end portion **65***a* of the optical fiber is disposed mask **66** which can be in the form of a substantially flat disk.

In the embodiment of FIGS. 10 and 11, at least a portion of the interior of the can is illuminated by the radiant energy from a source such as a light source **67**. The source is positioned in a manner which causes part of the light directed from it to intersect mask **66**. Due to the presence of mask **66**, a diffused shadow **68** is formed upon the surface of the paint when the paint is at the level shown in FIG. 10. The presence of the shadow reduces the amount of light reflected into optical fiber **65**.

As the level of paint continues to rise and approach the predetermined level in the container, shadow **68** moves closer to end portion **65***a* of the optical fiber and at the same time becomes denser. This change causes a steady reduction of the light being reflected to the optical fiber. When the paint is at the predetermined level within the container, mask **66** is closely spaced with respect to the surface of the paint so that the optical fiber **65** is exposed substantially, only to the shadow. As a result, the light reflected to optical fiber **65** is greatly reduced if not practically terminated. The reduction or the loss of light transmitted by optical fiber **65** results in the actuation of the photocell connected to the optical fiber. In this way the reduction or absence of the intensity of light as opposed to an increasing intensity of light serves to sense the presence of the surface of the paint at the predetermined level in the container.

The above described arrangement is illustrative of the principles of the invention. Other embodiments may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed:

1. A system for establishing a predetermined level of liquid paint material in a receptacle comprising:

(a) means for delivering liquid paint material to the interior of the receptacle;

(b) means for directing a high intensity narrow beam of radiant energy toward the interior of the receptacle;

(c) means adapted to be exposed to the interior of the receptacle and responsive to at least a portion of the changing radiant energy of said radiant energy directing means reflected from the surface of liquid paint material which is moving upwardly with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle for sensing the arrival of the surface of the material at the predetermined level within the receptacle; and

(d) means connected to said delivery means and responsive to said sensing means for abruptly terminating the delivery of liquid paint material to the receptacle in response to the sensing by said sensing means in order to establish the predetermined level of material in the receptacle.

2. A system for establishing a predetermined level of liquid paint material in a receptacle in accordance with claim **1** in which said means for directing a high intensity narrow beam of radiant energy toward the interior of the receptacle comprises a source of light.

3. A system for establishing a predetermined level of material in a receptacle comprising:

(a) means for delivering material to the interior of the receptacle.

(b) means for directing radiant energy toward the interior of the receptacle;

(c) a member having an aperture for receiving radiant energy reflected from the surface of the material;

(d) a mask member disposed adjacent said aperture of said receiving member and adapted to intercept a portion of the radiant energy from said radiant energy directing means before the portion of the radiant energy can be reflected from the surface of the material, the interception of the portion of the radiant energy forming a shadow in the pattern of the radiant energy directed by said radiant energy directing means onto the surface of the material within the receptacle, the size and the density of the shadow changing with changes in level of the surface of the material within the receptacle,

(e) means connected to said member having an aperture and responsive to the reduction of the radiant energy reflected from the surface of the material accompanying a predetermined condition of the shadow for sensing the presence of the surface of the material at the predetermined level within the receptacle; and

(f) means connected to said delivering means and responsive to said sensing means for terminating the delivery of the material to the receptacle in response to the sensing by said sensing means, whereby a predetermined condition of the changed shadow when the level of the surface of the material within the receptacle is at the predetermined level is adapted to activate the response of said sensing means.

4. A system for establishing a predetermined level of material in a receptacle in accordance with claim **3**:

(a) in which said member having an aperture for receiving radiant energy reflected from the surface of the material comprises optical fiber means; and

(b) in which said mask member comprises a disc extending about said optical fiber means adjacent an end portion thereof, whereby said disc intercepts a portion of the radiant energy and forms a shadow upon the surface of the material to which the radiant energy is directed.

5. A system for establishing a predetermined level of material in a receptacle comprising:

(a) means for delivering material to the interior of the receptacle;

(b) means for directing radiant energy toward the interior of the receptacle;

(c) means adapted to be exposed to the interior of the receptacle and responsive to at least a portion of the radiant energy of said radiant energy directing means reflected from the surface of the material within the receptacle for sensing the presence of the surface of the material at the predetermined level within the receptacle, said means exposed to the interior of the receptacle comprising:

(i) a member having an aperture for receiving radiant energy reflected from the surface of the material and

(ii) a mask member disposed adjacent said aperture and adapted to intercept a portion of the radiant energy from said radiant energy directing means before the portion reaches the surface of the material, the interception forming a shadow in the pattern of the radiant energy directed onto the surface of the material within the receptacle, the size and the density of the shadow changing with changes in level of the surface of the material within the receptacle, whereby a predetermined condition of the changed shadow is adapted to activate the response of said sensing means when the level of

the surface of the material within the receptacle is at the predetermined level; and

(d) means connected to said delivering means and responsive to said sensing means for terminating the delivery of the material to the receptacle in response to the sensing by said sensing means.

6. A system for establishing a predetermined level of material in a receptacle in accordance with claim **5**:

(a) in which said member having an aperture for receiving radiant energy reflected from the surface of the material comprises optical fiber means; and

(b) in which said mask member comprises a disc extending about said optical fiber means adjacent an end portion thereof, whereby said disc intercepts a portion of the radiant energy and forms a shadow upon the surface of the material to which the radiant energy is directed.

7. A system for establishing a predetermined level of material in a receptacle comprising:

(a) means for delivering material to the interior of the receptacle;

(b) means for directing radiant energy toward the interior of the receptacle;

(c) means adapted to be exposed to the interior of the receptacle and responsive to at least a portion of the radiant energy of said radiant energy directing means reflected from the surface of the material within the receptacle for sensing the presence of the surface of the material at the predetermined level within the receptacle;

(d) means connected to said delivering means and responsive to said sensing means for terminating the delivery of the material to the receptacle in response to the sensing by said sensing means; and

(e) means for advancing and retracting said means for directing radiant energy and at least a portion of said means for sensing the presence of the surface of the material with respect to an operative position adjacent to the interior of the receptacle, said advancing and retracting means being coupled to said means connected to said delivering means and responsive to said sensing means for terminating the delivery of the material to the receptacle in response to the sensing by said sensing means, the connecting of said advancing and retracting means to said terminating means activating said advancing and retracting means in response to the operation of said terminating means, whereby said radiant energy directing means and said portion of said sensing means can be advanced to an operative position adjacent the opening of said receptacle and retracted from said operative position after the sensing of the presence of the surface of the material at the predetermined level within the receptacle.

8. A system for establishing a predetermined level of material in a receptacle comprising:

(a) means for delivering material to the interior of the receptacle;

(b) means for directing a high intensity narrow beam of light toward the interior of the receptacle, said means for directing a high intensity narrow beam of light toward the interior of the receptacle including means having an end portion thereof for forming a high intensity zone of light on the surface of the material;

(c) means adapted to be exposed to the interior of the receptacle and responsive to at least a portion of the changing light of said light directing means reflected from the surface of the material moving upwardly with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle for sensing the arrival of the surface of the material at the predetermined level within the receptacle, said sensing means including:

(i) means having a first end portion exposed to the interior of the receptacle and a second end portion disposed at a distance therefrom for transmitting the light reflected from the surface of the material from said first end portion to said second end portion, said transmitting means having an end portion thereof for receiving light reflected from the high intensity zone of light on the surface of the material within the receptacle when the surface of the material is at the predetermined level within the receptacle, said end portion of said additional means being adapted to be exposed to the interior of the receptacle, and

(ii) a photoelectric device disposed adjacent said second end portion of said light transmitting means and being responsive to the light transmitted therethrough; and

(d) means connected to said delivering means and responsive to said sensing means for abruptly terminating the delivery of the material to the receptacle in response to the sensing by said sensing means in order to establish the predetermined level of material in the receptacle.

9. A system for establishing a predetermined level of material in a receptacle comprising:

(a) means for delivering material to the interior of the receptacle;

(b) means for directing a high intensity narrow beam of radiant energy toward the interior of the receptacle, said radiant energy directing means including a source of light;

(c) means adapted to be exposed to the interior of the receptacle and responsive to at least a portion of the changing light of said radiant energy directing means reflected from the surface of the material which is moving upwardly with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle for sensing the arrival of the surface of the material at the predetermined level within the receptacle, said sensing means including:

(i) means having a first end portion exposed to the interior of the receptacle and a second end portion disposed at a distance therefrom for transmitting the light reflected from the surface of the material from said first end portion to said second end portion; and

(ii) a photoelectric device disposed adjacent said said second end portion of said light transmitting means and being responsive to the light transmitted therethrough; and

(d) means connected to said delivering means and responsive to said sensing means for abruptly terminating the delivery of the material to the receptacle in response to the sensing by said sensing means in order to establish the predetermined level of material in the receptacle.

10. A system for establishing a predetermined level of material in a receptacle comprising:

(a) means for delivering material to the interior of the receptacle;

(b) means for directing radiant energy toward the interior of the receptacle, said radiant energy directing means including a source of light and optical fiber means having an end portion thereof for directing light, said end portion being adapted to be exposed to the interior of the receptacle;

(c) means adapted to be exposed to the interior of the receptacle and responsive to at least a portion of the changing light of said radiant energy directing means reflected from the surface of the material moving with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle for sens-

ing the arrival of the surface of the material at the predetermined level within the receptacle, said sensing means including:

(i) means extending to adjacent said delivering means for transmitting the light reflected from the surface of the material, said transmitting means including additional optical fiber means having an end portion thereof for receiving light reflected from the surface of the material within the receptacle when the surface of the material is at the predetermined level within the receptacle, said end portion of said additional optical fiber means being adapted to be exposed to the interior of the receptacle, and

(ii) a photoelectric device which is disposed adjacent said light transmitting means and which is responsive to the light transmitted therethrough; and

(d) means connected to said delivering means and responsive to said sensing means for terminating the delivery of the material to the receptacle in response to the sensing by said sensing means.

11. A system for establishing a predetermined level of material in a receptacle in accordance with claim **10** in which said end portion of said optical fiber means and said end portion of said additional optical fiber means are disposed adjacent to one another.

12. A system for establishing a predetermined level of material in a receptacle in accordance with claim **11** in which the end portion of said optical fiber means and the end portion of said additional optical fiber means are substantially contiguous with one another.

13. A system for establishing a predetermined level of material in a receptacle in accordance with claim **10** in which said optical fiber means is disposed at a predetermined angle with respect to the surface of the material within the receptacle when the surface of the material is at the predetermined level within the receptacle and in which said additional optical fiber means is disposed at another predetermined angle with respect to the surface of the material within the receptacle when the surface of the material is at the predetermined level within the receptacle, the additional predetermined angle of said additional optical fiber means enabling the light from said optical fiber and reflected from the surface of the material to be transmitted by said additional optical fiber means only when the surface of the material in the receptacle is at the predetermined level.

14. A system for establishing a predetermined level of material in a receptacle comprising:

(a) means for delivering material to the interior of the receptacle;

(b) means for directing radiant energy toward the interior of the receptacle;

(c) means adapted to be exposed to the interior of the receptacle and responsive to at least a portion of the changing radiant energy of said radiant energy directing means reflected from the surface of the material moving with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle for sensing the arrival of the surface of the material at the predetermined level within the receptacle;

(d) means connected to said delivering means and responsive to said sensing means for terminating the delivery of the material to the receptacle in response to the sensing by said sensing means; and

(e) means for advancing and retracting said means for directing radiant energy and at least a portion of said means for sensing the arrival of the surface of the material with respect to an operative position of said advancing and retracting means adjacent to the interior of the receptacle for each cycle of operation of said system, whereby said radiant energy directing means and said portion of said sensing means can be advanced to an operative position adjacent the opening of said receptacle and retracted from said operative position after the sensing of the arrival of the surface of the material at the predetermined level within the receptacle.

15. A system for establishing a predetermined level of material in a receptacle comprising:

(a) means for delivering material to the interior of the receptacle;

(b) means for directing radiant energy toward the interior of the receptacle;

(c) means adapted to be exposed to the interior of the receptacle and responsive to at least a portion of the changing radiant energy of said radiant energy directing means reflected from the surface of the material moving with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle for sensing the arrival of the surface of the material at the predetermined level within the receptacle;

(d) means connected to said delivering means and responsive to said sensing means for terminating the delivery of the material to the receptacle in response to the sensing by said sensing means; and

(e) means for activating said means for terminating the delivery of the material to the receptacle in response to the operation of said means for delivering material to the interior of the receptacle for a predetermined period of time which is greater than the period of time necessary to deliver material in an amount to bring the surface of the material in the receptacle to the predetermined level within the receptacle, whereby the delivery of the material to the receptacle is safeguard against an overfilling condition.

16. A method for establishing a predetermined level of liquid paint material in a receptacle comprising the steps of:

(a) delivering liquid paint material to the interior of the receptacle;

(b) directing a high intensity narrow beam of radiant energy toward the interior of the receptacle;

(c) sensing the arrival of the liquid paint material at the predetermined level within the receptacle in response to at least a portion of the changing radiant energy of the radiant energy directed toward the interior of the receptacle which is reflected from the surface of the liquid paint material which is moving upwardly with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle; and

(d) abruptly terminating the delivery of the liquid paint material to the receptacle in response to the sensing of the arrival of the liquid paint material at the predetermined level in order to establish the predetermined level of liquid paint material in the receptacle.

17. A method for establishing a predetermined level of material in a receptacle comprising the steps of:

(a) delivering material to the interior of the receptacle;

(b) directing light toward the interior of the receptacle by directing light through optical fiber means which has an end portion extended into and exposed to the interior of the receptacle;

(c) sensing the arrival of the material at the predetermined level within the receptacle in response to at least a portion of the changing light of the light directed toward the interior of the receptacle which is reflected from the surface of the material moving with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle, said step of sensing including transmitting the light reflected from the surface of the material by means of an

additional optical fiber means having an end portion thereof for receiving light reflected from the surface of the material within the receptacle when the surface of the material is at the predetermined level within the receptacle, the end portion of the additional optical fiber means being extended into and exposed to the interior of the receptacle; and

(d) terminating the delivery of the material to the receptacle in response to the sensing of the arrival of the material at the predetermined level.

18. A method for establishing a predetermined level of material in a receptacle comprising the steps of:

(a) delivering material to the interior of the receptacle;

(b) directing light toward the interior of the receptacle by directing light from a source extended into the interior of the receptacle at a predetermined angle to the surface of the material in the receptacle, the predetermined angle being measured when the surface of the material is at the predetermined level;

(c) sensing the arrival of the material at the predetermined level within the receptacle in response to at least a portion of the changing light of the light directed toward the interior of the receptacle which is reflected from the surface of the material moving with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle, the step of sensing including receiving light within the interior of the receptacle which has been directed toward the surface of the material and reflected therefrom at another predetermined angle when the surface of the material is at the predetermined level within the receptacle; and

(d) terminating the delivery of the material to the receptacle in response to the sensing of the arrival of the material at the predetermined level.

19. A method for establishing a predetermined level of material in a receptacle comprising the steps of:

(a) delivering material to the interior of the receptacle;

(b) directing radiant energy toward the interior of the receptacle;

(c) sensing the arrival of the material at the predetermined level within the receptacle in response to at least a portion of the changing radiant energy of the radiant energy directed toward the interior of the receptacle which is reflected from the surface of the material moving with respect to the height of the receptacle when the surface of the material is moved to substantially the predetermined level within the receptacle, said step of sensing including,

(i) providing a member having an aperture for receiving radiant energy reflected from the surface of the material, and

(ii) intercepting a portion of the radiant energy being directed toward the surface of the material before the portion of the radiant energy can be reflected from the surface of the material, the interception of the portion of the radiant energy forming a shadow in the pattern of the radiant energy on the surface of the material within the receptacle, the size and the density of the shadow changing with changes in level of the surface of the material within the receptacle whereby a predetermined condition of the changed shadow senses the presence of the level of the surface of the material within the receptacle at the predetermined level; and

(d) terminating the delivery of the material to the receptacle in response to the sensing of the arrival of the material at the predetermined level.

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U.S. Cl. X.R.

222—65; 250—222

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,536,925 Dated October 27, 1970

Inventor(s) Richard Schmidt

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 59, "weight" should be -- weigh --

Column 2, line 69, "persepective" should be -- perspective --

Column 6, line 31, after "48," insert -- the relay has two different "neutral" conditions (relay de --

SIGNED AND
SEALED
FEB 9 [illegible]

FEB. 9, 1971

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents