

[54] **ROTATABLE PARABOLOIDAL RESERVOIR
USEFUL IN AN INK JET PRINTER**

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239/7**

[56] **References Cited**

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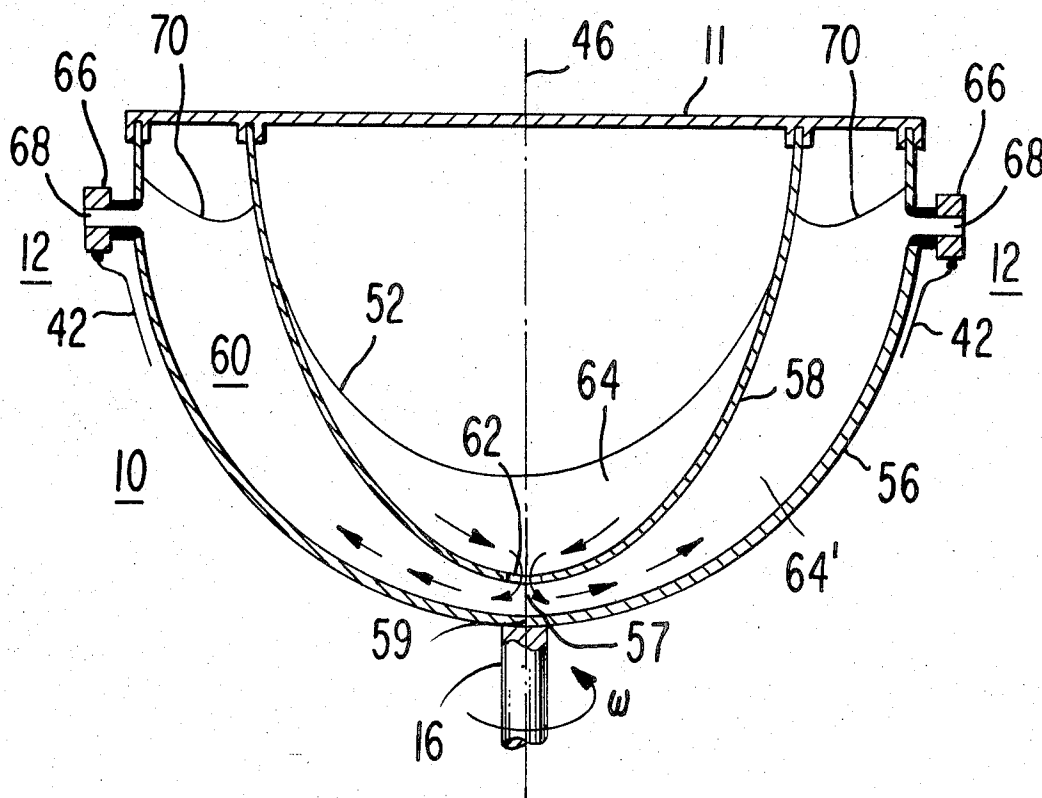
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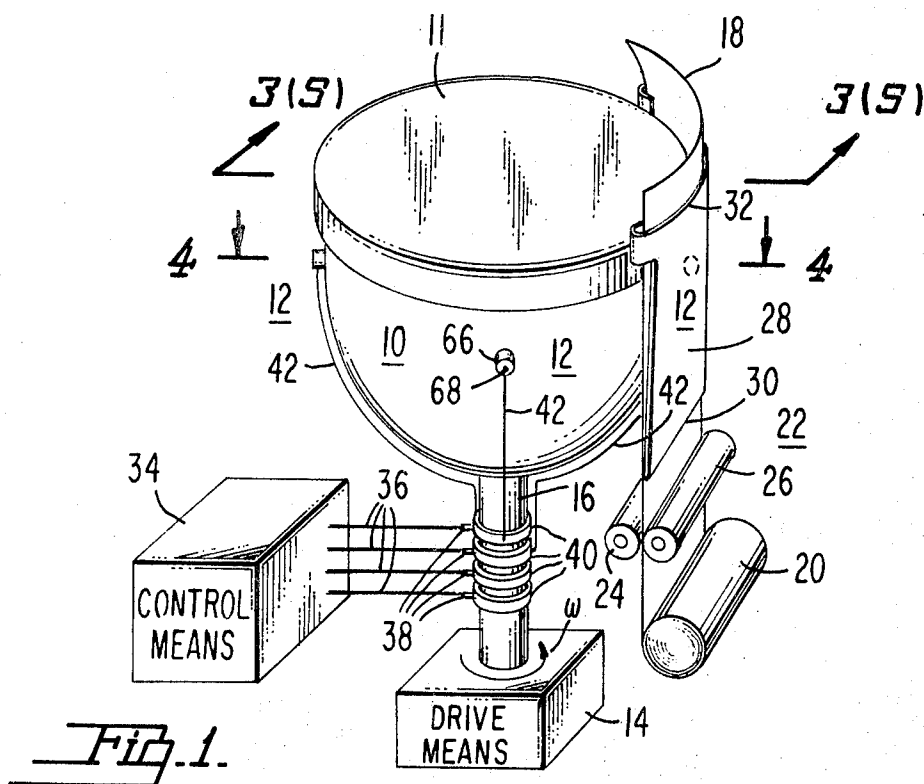
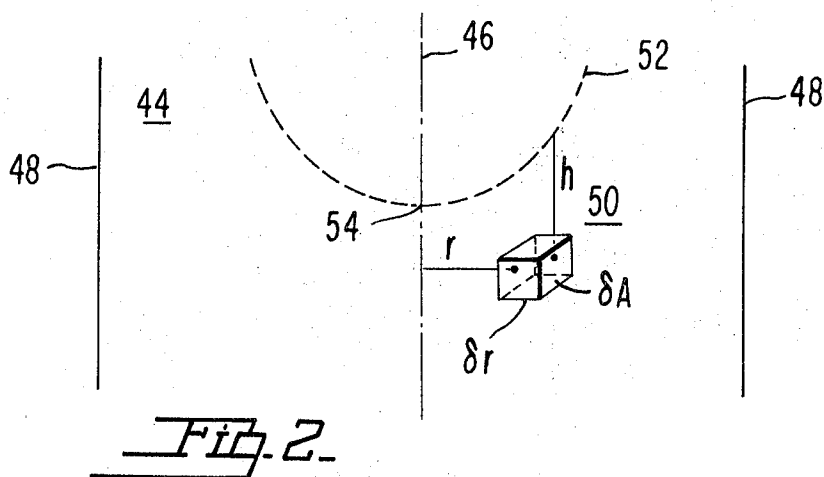
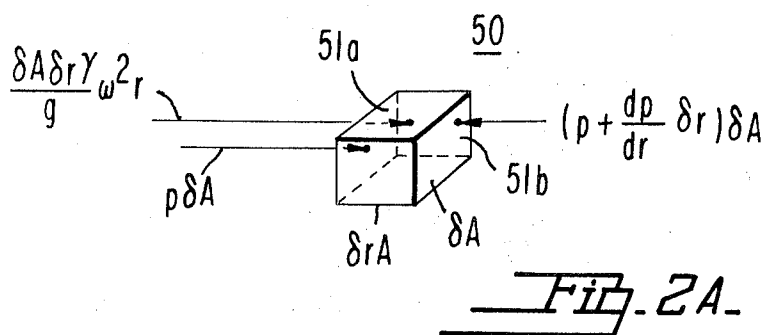
ABSTRACT

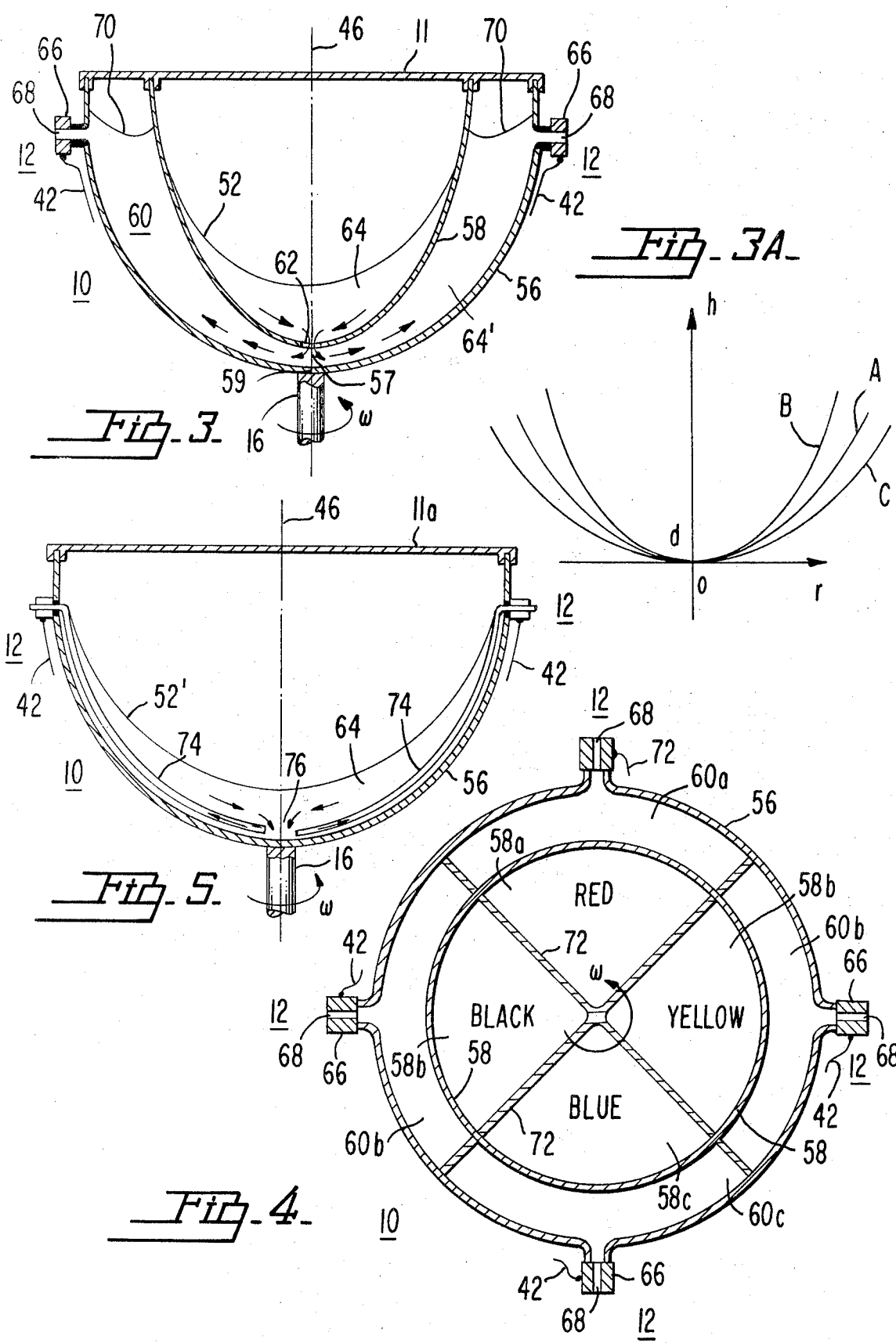
An ink reservoir having the form of a vertical paraboloid of revolution is provided with ink jets directed radially outward. The reservoir is rotated about its axis while paper is driven past the ink jets which are selectively operated to eject ink on to the paper. The reservoir has a parabolic passageway adjacent to its wall and conforming to its shape through which ink stored in the reservoir flows to the ink jets. The paraboloidal shape of the reservoir and its angular velocity are such that the ink is forced up to the ink jets through the parabolic passageway regardless of the amount of ink in the reservoir. The parabolic passageway prevents the centrifugal force and the pressure head of the stored ink from acting on the ink adjacent to the ink jets and thereby causing unwanted leakage there-through.

9 Claims, 7 Drawing Figures



SHEET 1 OF 2





ROTATABLE PARABOLOIDAL RESERVOIR USEFUL IN AN INK JET PRINTER

ENVIRONMENT OF THE INVENTION AND PRIOR ART

The invention herein disclosed pertains to an ink jet printer wherein ink jets, mounted on the periphery of an ink reservoir, which is rotated about a vertical axis, are selectively activated to eject ink as they are swept past a printing medium. The reservoir is usually a cylinder and the jets extend radially outward from its periphery at equally spaced intervals and at a uniform height above the base of the cylinder. The ink jets may be simple tubes equipped with a piezoelectric constrictor or other pump element. Such jets cannot sustain a substantial pressure, due to combined effects of the head pressure and the centrifugal force of the ink contained in the reservoir, without leaking since the ink jets are opened tubes. In the printing art leaking of ink is undesirable.

Design of a suitable ink jet printer involves satisfying several objectives. The first, already discussed, requires that the ink jets not leak at the rated angular velocity of the reservoir required to establish the desired printing speed. Secondly, the reservoir must have the capacity for extended printing usage. The third, related to the second, is the full utilization of all the ink in the reservoir.

Several solutions may be utilized to provide such a suitable printer. For example, if the jets are placed at the bottom of the reservoir, all the ink in the reservoir will be available to the jets. However, the pressure at the depth of the full reservoir and the radial centrifugal forces may cause leakage through the jets. One solution is to limit the angular velocity of the reservoir. A second solution is to limit its capacity. A combination of the two solutions may also be used. None of these proposals has provided a satisfactory printer.

Another variation is to place the ink jets near the top of the reservoir whereby the pressure head at the location of the ink jets is less than if they were at a greater depth. It should be apparent, however, that a large portion of the ink will never reach the ink because the ink level will eventually fall below the location of the ink jets as it is utilized.

An improved ink jet printer is needed whereby the deficiencies of the conventional printers are overcome.

SUMMARY OF THE INVENTION

According to the present invention, fluid is provided in a passageway having an upwardly sloped path. An entrance for the fluid is provided at a port along the passageway. The passageway is rotated about a vertical axis at an angular velocity sufficient to cause the fluid to rise upward to an output port, located at a point above the input port, where the fluid is utilized.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of an ink jet printing apparatus embodying the present invention;

FIG. 2 is a schematic of a portion of a fluid container in rotation about a vertical axis showing an incremental fluid portion therein;

FIG. 2A is an enlarged fragmentary view of a portion of FIG. 2 showing the forces acting on the fluid portion shown in FIG. 2;

FIG. 3 is a vertical cross-sectional view of an ink reservoir embodying the invention and useful in an ink jet printing apparatus such as that in FIG. 1 as viewed along section line 3—3;

FIG. 3A is a set of graphs of three parabolas illustrating a principle of the invention;

FIG. 4 is a horizontal cross-sectional view, taken at section 4—4 of FIG. 1, of the ink reservoir of FIG. 3 modified for multi-color printing;

FIG. 5 is a vertical cross-sectional view, taken at section 5—5 of FIG. 1, of another ink reservoir embodying the invention.

In each of the Figures like reference designations indicate the same element.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a schematic diagram of an ink jet printing apparatus which embodies the present invention. Reservoir 10, of generally parabolic form, contains ink which flows along internal paths to ink jets 12 located at regular spaced positions about its periphery and at a uniform height along its axis. Reservoir 10 has the form of a paraboloid of revolution for the reasons that will be described. Reservoir 10 is closed by removable cover 11. Reservoir 10 is rotated about its vertical axis, held in a vertical position, at an angular velocity ω , by drive means 14 coupled thereto by drive shaft 16. Paper 18, or other printing medium, is suitably driven past ink jets 12 in cooperation with the rotating reservoir as is known in the art.

Paper 18 is supplied from supply roll 20 and is received between rollers 24 and 26 which comprise pinch roller assembly 22. Pinch rollers 24 and 26 are urged against each by a spring mechanism or other suitable means, not shown. Either or both pinch rollers 24 and 26 are suitably driven, by means not shown, to urge a suitable paper upward and along warped guide member 28. Warped guide member 28 is described in detail in U.S. Pat. application, Ser. No. 192,209, filed Oct. 26, 1971, entitled "Printing Apparatus" by Kenneth Fischbeck and assigned to the same assignee as the present application. Warped guide member 28 receives, at its straight line portion 30, paper 18 as it emerges from rollers 24 and 26. Curved line portion 32 of curved guide member 28 is arranged to conform paper 18 close to the circular periphery of reservoir 10 as it is driven past ink jets 12.

Ink jets 12 are operated in accordance with print-control signals from control means 34 to selectively eject ink on the surface of paper 18 whereby the ink pattern manifested represents the information of the signals. The control signals are conducted by conductor 36 to brushes 38 which contact slip rings 40. Conductor 42 is connected between the commutator rings and ink jets 12. Although conductor 42 is shown as running along the surface of reservoir 10 for illustrative purposes, they may be buried in the wall material forming the reservoir 10. The return path for the control signal carried by conductor 42 is not shown. If the reservoir were constructed of metal, it could carry the return signal.

Ink jets 12, of conventional form for pumping or metering ink, comprise a tube or capillary surrounded by

a piezoelectric constrictor 66. When a voltage is applied to piezoelectric constrictor 66, tube portion 68 is squeezed and ink within it is ejected. The amount of ejected ink is determined by the magnitude and duration of the applied voltage. Although piezoelectric jets are preferred because of their simplicity, low cost, and capability of operating at the rated printing speed, any suitable ink jet may be used as the pump or metering element which is operable upon the reception of a command signal.

In conventional color ink jet printing apparatus, reservoir 10 is divided into compartments, with each compartment containing one of the subtractive primary colors, magenta, yellow and cyan, or black and having an associated ink jet 12. Ink jet printing apparatus 1 has four control signal paths (each consisting of a wire 36, a brush 38, a slip ring 40, and a wire 42) coupling control means 34 to four ink jets 12. Each ink jet 12 is supplied with a different color ink from a respective reservoir and is controlled by a respective control signal. It should be noted that a printing apparatus employed in single color printing may also use a plurality of ink jets to increase thereby the writing speed.

Reservoir 10 either may be a replaceable throw-away cartridge or, if desired, may be refillable by replacing ink from the top after removing cover 11.

In operation, reservoir 10 is placed on shaft 16 and rotated. Printing is accomplished by selectively energizing an ink jet 12 as it passes the location of paper 18 in response to the control signals. When one line of printing is completed, paper is driven upward by a pinch roller assembly 22. In multi-color printing, one line of print corresponds to one complete rotation of reservoir 10, whereas, in single color printing, one line of print corresponds to the sweep of a single ink jet 12 across paper 18 requiring, thus, an increased paper advance speed. At the end of an entire page of print, the paper may be cut off at the curve line portion 32 of guide member 28 or, alternatively, collected by a take up roll, not shown.

Before describing in detail reservoirs embodying the present invention, the dynamic characteristics of a fluid rotated about a vertical axis will be described. In FIG. 2, an incompressible fluid 44 is rotated about a vertical axis 46 at an angular velocity ω in a container having walls 48. For the purpose of this description, fluid 44 is assumed to consist of an infinite number of incrementally small cubes 50 of fluid 44 radially spaced from axis 46 by distance r and having sides of incremental area δA and incremental length δr . As fluid 44 is rotated, cube 50 is subject to a radial acceleration, and consequentially, a centrifugal force which pushes it radially outward. Simultaneously, cube 50 is subjected to a head pressure, which directly depends on its vertical distance from its free surface 52, which acts upon the cube uniformly from all directions. Cube 50 continues to move until free surface 52 assumes a shape in accordance to the movement of fluid 44 such that the hydrostatic pressure and the centrifugal force acting on cube 50 are equal.

FIG. 2A is a diagram of the forces acting on cube 50 as it is accelerated radially outward due to the rotation of fluid 44 shown in FIG. 2. The force due to the pressure acting on one face of cube 50 is equal to the product of the pressure at that face and the incremental area of that face, δA . The difference between the pressures at faces 51a and 51b is the increase of pressure

due to the incremental increase of radial distance, δr , between them. Between faces 51a and 51b, over the incremental distance δr , the differential rate of change of pressure is expressed as dp/dr . Therefore, the increase of pressure at face 51b above the pressure at face 51a is $(dp/dr) \delta r$. The force acting at face 51a has a magnitude of $p\delta A$ resulting in block 50 being forced radially outward. The force acting at face 51b is $(p + (dp/dr) \delta r) \delta A$ causing the block 50 to be forced radially inward. The centrifugal force acting on a body moving in a circular path around an axis at angular velocity ω , at a radial distance r and having a mass m may be expressed by the relation: $m\omega^2 r$. The weight of cube 50 is the product of its specific weight (weight per unit volume) γ and its volume, which product is thus expressed as $\delta A \delta r$. Since the mass of an object is its weight divided by the acceleration of gravity, g , the mass, m , of cube 50 is $\delta A \delta r \gamma / g$ and the centrifugal force pushing it radially outward is $(\delta A \delta r \gamma / g) \omega^2 r$. The equation of the forces acting on cube 50 is:

$$\delta A \delta r \gamma / g (\omega^2 r) + p \delta A = (p + [dp/dr] \delta r) \delta A \quad (1)$$

After algebraically simplifying, equation (1) results in:

$$dp/dr = (\gamma/g) \omega^2 r \text{ or } dp = (\gamma/g) \omega^2 r dr \quad (2)$$

Integrating both sides of the above equation (2) results in:

$$p = (\gamma/g) (\omega^2 r^2 / 2) + c \quad (3)$$

where c is the constant of integration. Expression (3) is an equation of a family of parallel parabolas and indicates that along the path of any one of such parabolas, the pressure is constant. For equilibrium, as stated above, the force due to head pressure at any point within fluid 44 must balance the centrifugal forces acting thereon. The force of the head pressure of a point within a fluid is equal to the produce of its vertical height h from the fluid's free surface 52 as it rotated and its specific weight. Therefore:

$$h\gamma = \gamma/g (\omega^2 r^2 / 2) + c \text{ or } h = (\omega^2 r^2 / 2g) + c/\gamma \quad (4)$$

Equation (4) also describes a parabola and indicates that the free surface 52 (FIG. 2) of fluid 44 rotated about vertical axis 46 at a fixed angular velocity ω is formed into a portion of a parabola which rises as the square of the radial distance r from axis 46. If the perpendicular coordinate axes of radial distance and vertical height are chosen to have their origin at the parabola's vertex 54, the equation for height of the fluid above the vertex as a function of radial distance takes the form of $h = \omega^2 r^2 / 2g$.

Therefore, it will now be understood that fluid in a container rotated about a vertical axis at a fixed angular velocity rises in a parabolic path so as to create a difference in head pressure to counteract the pressure differential due to the centrifugal force. The three dimensional shape of the fluid thus created is a paraboloid of revolution.

FIG. 3 is a cross-sectional view of ink reservoir 10 taken through the viewing plane 3—3 of ink jet printing apparatus 1 of FIG. 1 which illustrates one embodiment of the invention in which the principles of fluid dynamics just described are utilized. Reservoir 10 is formed of inner paraboloidal container 58 coaxially inserted within outer paraboloidal container 56. Inner paraboloidal container 58 has its vertex 57 vertically displaced

along axis 46 from the vertex 59 of outer paraboloidal container 56 to form thereby passageway 60 between the two paraboloidal containers. Inner and outer paraboloidal containers, respectively, 58 and 56, have different paraboloidal shapes which depend on the rated angular velocity, ω , at which reservoir 10 is rotated about its axis 46 as will be described. Although the passageway 60 should not be termed a parabola, it will be appreciated that as the spacing between the two containers 56 and 58 is reduced; such a passageway 60 more nearly becomes a parabola. For the purposes of the present description, the passageway 60 shall be referred to as a parabolic passageway. An orifice 62 is located at the vertex 57 of inner paraboloidal container 58 so that ink 64 stored therein may flow to passageway 60. The containers 56 and 58 can be constructed from any substantially non-flexible material, including plastic, suitable for use as a throw-away cartridge. The two paraboloidal containers 56 and 58 are suitably spaced apart by structural members, not shown. The form, number and location of such structural members should not impede the flow of ink 64 between inner paraboloidal container 58 and ink jets 12. Ink jets 12 radially extend outward from outer parabolic container 56 and communicate between passageway 60 and the exterior of reservoir 10. Ink jets 12 can be affixed to reservoir 10 by any conventional manner. For instance, they may be provided with threading which would allow them to be removeable for purposes of cleaning or replacement. Cover 11 is removeably mounted on the open ends of the two paraboloidal containers 56 and 58 by means of press fit, threading, or in any other suitable manner so that reservoir 10 may be loaded with ink, if desired. Reservoir 10 coacts with the remainder of printing apparatus 1 in the same manner as was previously explained with respect to the detailed description of FIG. 1.

When reservoir 10 is rotated about axis 46 at angular velocity ω , surface 52 of ink 64, within inner paraboloidal container 58, assumes a paraboloidal shape directly dependent on ω^2 according to equation (4).

In FIG. 3A, parabolic curve A represents the cross section of the paraboloidal shape of fluid surface 52 shown in FIG. 3. Parabolic curves B and C represent the cross-sections of the inner and outer paraboloidal reservoirs, respectively, 58 and 56. Outer paraboloidal container 56 is arranged to widen more rapidly as a function of vertical height, h , than does the paraboloidal shape of surface 52 of ink 64, noting that the shape of surface 52 is determined by the fixed, predetermined angular velocity of the rotating printing head reservoir. Inner paraboloidal container 58, however, is arranged to widen less rapidly as a function of vertical height h than does the paraboloidal shape of surface 52 of ink 64. The difference in curves A, B and C may also be expressed in terms of slopes. As used in the remainder of the specification, the term slope means the average rate of change in vertical height with respect to a change in radial distance. The slope of curve C (outer paraboloidal container 56) is less than the slope of curve A (free surface 52 of ink 64) while the slope of curve B (inner paraboloidal container 58) is greater than the slope of curve A. The differences in the various parabolic shapes in FIGS. 3 and 3A are exaggerated, it should be understood, to facilitate an understanding of the operation of reservoir 10 according to this invention. The size of parabolic passageway 60 in comparison to the

overall size of reservoir 10 is also exaggerated for the same reason.

When reservoir 10 is not rotated, ink 64 will assume the same level in both inner paraboloidal container 58 and parabolic passageway 60. As rotation begins, ink 64 in passageway 60 begins to rise upward in a parabolic path toward ink jets 12. At the predetermined steady state angular velocity ω , ink 64 in passageway 60 is sustained above ink jets 12. As ink 64' in parabolic passageway 60 is depleted through ink jets 12, it is replenished by ink 64 from within inner paraboloidal container 58 passing to passageway 60 through vertex orifice 62. As long as there is ink 64 in inner paraboloidal container 58, the volume of ink 64 in parabolic passageway 60 will be kept substantially constant. Under these conditions, the height of ink 64' in parabolic passageway 60 is solely dependent on the volume of ink 64' in the passageway and angular velocity ω of reservoir 10. Surface 70 of ink 64' within passageway 60 follows a complex curve which tends to be both paraboloidal due to the rotation of reservoir 10 as well as tending to be a meniscus if passageway 60 is so narrow as to have the properties of a capillary. The arrows shown in FIG. 3 indicate generally the flow of ink from inner paraboloidal container 58, through orifice 62, and up to ink jets 12 through parabolic passageway 60.

Inner paraboloidal container 58 having a parabolic cross-sectional curve B which is steeper than the parabolic cross-sectional curve A of surface 52 of ink 64, tends to cause all the ink 64 to exit downward through orifice 62 into parabolic passageway 60. Further, outer paraboloidal container 56 having a parabolic cross-sectional curve C which widens more rapidly as a function of vertical height, h , than does the parabolic cross-sectional curve A of surface 52 of ink 64, ink remaining in parabolic passageway 60 after ink in inner paraboloidal container 58 is depleted, flows to ink jets 12 in an ever decreasing paraboloidal ink layer, whose surface conforms to the same family of parabolas as curve A. When inner paraboloid container 58 still contains ink, the head pressure within parabolic passageway 60 is a function of the vertical distance from the wall of inner paraboloidal container 58 and can be quite small if the spacing of parabolic passageway 60 is made small. When the ink is depleted from inner container 58, the pressure at any point within such a relatively thin paraboloidal ink layer flowing upwardly along the wall of outer paraboloidal container 56 is a function of its vertical distance from its free surface and is also quite small. As a result of the geometrical structure of reservoir 10, leakage of ink 64 through ink jets 12 is minimized while its storage capacity and ink utilization is maximized. Although the embodiment of FIG. 3 is based on an inner paraboloidal container having a steeper slope than the free surface of the fluid to assure full use of the ink therein, it will be appreciated that the inner container having less slope than the slope of the free surface will still be useful even though full use of the ink is not achieved.

FIG. 4 is a sectional view of reservoir 10 of FIG. 3, taken horizontally at the vertical height of ink jets 12 along viewing lines 4-4, showing structural modifications for multi-color printing. Criss-cross member 72 divides reservoir 10 into four equal quadrants or compartments. Each quadrant comprises a quadrant, 58a, 58b, 58c and 58d, of inner parabolic container 58 communicating, respectively, with a quadrant, 60a, 60b,

60c and 60d of parabolic passageway 60 via a separate orifice located at the vertex of inner paraboloidal container 58. An ink having one of the subtractive primary colors, red, yellow and blue, or black is placed into a respective one of the four compartments. In operation, the reservoir of FIG. 4 is similar to that for the reservoir of FIG. 3. Ink contained in each of quadrants, 58a, 58b, 58c and 58d of inner paraboloidal container 58 flows through a respective orifice at the vertex of inner paraboloidal container 58 to a respective quadrant 60a, 60b, 60c and 60d of parabolic passageway 60 and upward, in a parabolic path, to a respective ink jet, 12a, 12b, 12c and 12d where it is selectively ejected as the ink jet is swept past the printing material as reservoir 10 is rotated about its axis.

It is to be noted that ink jets 12 in the embodiment of FIG. 4 are somewhat outwardly extended from the periphery of outer paraboloidal container 56. The purpose of this funnel-like extension is to ensure that the remnants of the ink, when the reservoir is almost depleted, reaches ink jets 12 as it rises upwardly along the inner side of outer paraboloidal container 56.

FIG. 5 is a vertical cross-sectional view of another modification of ink reservoir 10 useful in ink jet printing apparatus 1 of FIG. 1 embodying the present invention. As in FIG. 3, paraboloidal container 56 having cover 11a is coaxially mounted on drive shaft 16 and has ink jets 12 each mounted in spaced relation at a predetermined height around the periphery. However, in this embodiment, a tube 74 is provided along the inner side of paraboloidal container 56 preferably between the vertex of paraboloidal container 56 and an ink jet 12 to form passageway by which ink 64 stored within paraboloidal container may flow through the orifice 76 of tube 74 to ink jet 12 along a parabolic path defined by tube 74. When reservoir 10 is rotated about axis 46, surface 52' of ink 64 forms into a paraboloid of revolution. Additional tubes 74 are provided and arranged in similar fashion for each additional ink jet 12 provided on the printer ink container. As in FIG. 3, the parabolic shape of paraboloidal container 56 (curve C) is arranged to widen more rapidly as a function of vertical height, h , than does surface 52 of ink 64 (curve A) generated by the rotation thereof at the predetermined speed required.

At standstill, ink 64 enters tube 74 through its orifice 76 and rises to a level somewhat higher than its level in paraboloidal container 56 due to capillary action co-acting with the ink's propensity to achieve its own level. As reservoir 10 is rotated about its axis, the ink in tube 74 rises upward in a parabolic path to ink jet 12 where it is selectively ejected. As long as there is sufficient ink 64 in paraboloidal container 56 to supply tube 74, a constant volume of ink will be maintained in tube 74. The height of ink 64 within tube 74 under these conditions is dependent on angular velocity ω and the volume of ink 64 in tube 74. Even though ink 64 in paraboloidal container 56 is depleted to the extent that it will no longer be great enough to maintain a constant volume of ink 64 in tube 74, ink will be supplied to the jet 12 according to the invention since the ink flows along the parabolic path of the tube 74 determined by the contour of the container 56. The head pressure at a point within tube 74 is a function of its vertical distance from the top most portion of tube 74 and can be quite small if the diameter of tube 74 is made small.

Although the preferred form of the reservoir container was described in terms of being of paraboloidal form, it will be appreciated by those skilled in the art that other similar curvilinear as well as linearly sloped members or cones may be used to conduct ink to the ink jets.

It should now be understood that an improved ink jet printer is provided according to this invention which solves the problem of supplying large volumes of ink without causing the ink jets to leak as a result of the combined effects of centrifugal force and head pressure on the ink. By providing the ink reservoir, rotated at the required printing speed, with a passageway sloped upwardly toward the ink jets in critical relation to the slope of the rotated fluid and thereby the speed of rotation, the ink in the passageway will be supplied to the ink jet with the minimum of force required to supply the ink jet.

What is claimed is:

1. A method for causing a fluid to rise from a first point to a second point above said first point comprising the steps:

guiding said fluid through an input port located at the first point into a passageway for fluid following a generally parabolic course, the axis of the parabola being vertically orientated and the vertex of the parabola being directed downward;

rotating said parabolic passageway about said vertical axis at an angular velocity at which the free surface of fluid within said passageway forms a paraboloidal shape having a slope which is greater than the slope of said parabolic passageway such that said fluid within said passageway rises from said first point to said second point and the head pressure of said fluid with said passageway is substantially minimized; and

metering the flow of said fluid from said parabolic passageway through an output port located at said second point;

whereby fluid is supplied to said second point at a pressure no greater than a predetermined pressure.

2. In combination:

a passageway for fluid following an upwardly sloped course, said passageway having a substantially uniform cross-section;

a fluid metering element of the type incapable of sustaining a predetermined input pressure mounted on said passageway for ejecting fluid from said passageway;

an input port for fluid to enter said passageway located at a point on said passageway below said metering element; and

means for rotating said passageway about a vertical axis at an angular velocity at which the slope of the free surface of fluid within said passageway is generally the same as the slope of said upwardly sloped course such that said fluid within said passageway rises from said input port to said metering element and the head pressure of said fluid within said passageway is substantially minimized whereby fluid is supplied to said metering element at a pressure no greater than said predetermined input pressure.

3. The combination recited in claim 2 wherein said passageway follows a generally parabolic course, the axis of the parabola being vertically orientated and the vertex of the parabola being directed downward; and

wherein said parabolic passageway is rotated about its axis.

4. A rotatable reservoir, comprising:

a container for fluid having the form of a paraboloid of revolution, the axis of said paraboloidal container being vertically orientated, and the vertex of said paraboloidal container being directed downward;

a passageway for said fluid adjacent to the wall of said paraboloidal container, said passageway having a generally uniform cross-section, and having an entrance port by which fluid from said container enters said passageway;

an ink jet directed radially outward and communicating with said passageway to eject fluid radially outwardly;

means for rotating said paraboloidal container about its axis at an angular velocity such that said fluid rises upwardly in said passageway to provide fluid to said ink jet; and

means for metering fluid passing through said ink jet.

5. The reservoir recited in claim 4 wherein said passageway is formed between said first mentioned container and a second container, having the form of a paraboloid of revolution, coaxially inserted within said first-mentioned paraboloidal container and similarly orientated; said second paraboloidal container having an orifice at its vertex through which fluid contained therein enters said passageway.

6. The reservoir recited in claim 5 wherein the slope of said second paraboloidal container is greater than the slope of the paraboloidal surface of the fluid formed by the rotation of said container, whereby said fluid flows downwardly to said orifice.

7. The reservoir recited in claim 4 wherein said passageway comprises a tube having an entrance receptive of the fluid within said paraboloidal container located at the vertex thereof, and running along the wall of said paraboloid character to said ink jet.

8. An ink jet printing apparatus, comprising:

a first container in the form of a first paraboloid of revolution, having its axis vertically orientated, and having its vertex directed downward;

a jet located at the periphery of said first container and directed radially outward therefrom;
means for controlling the flow of ink through said jet;

means for guiding a printing medium past said jet;

a second container for storing ink in the form of a second paraboloid of revolution coaxially inserted in said first container with its vertex directed downward so that a passageway is formed between said first and second containers; said first and second containers having thereby a common axis of revolution;

said second container having an aperture at its vertex through which ink stored therein flows into said passageway; said passageway providing a flow path between the second container and said jet;

means for rotating said containers about said axis with an angular velocity such that the paraboloidal shape of the surface of the ink stored in said second container widens less rapidly as a function of height than does said first paraboloid of revolution, but more rapidly as a function of height than does said second paraboloid of revolution.

9. An ink jet printing apparatus, comprising:

a container in the form of a paraboloid of revolution, having its axis vertically orientated, and having its vertex directed downward; said container being a reservoir for storing ink;

a jet located at the periphery of said container and directed radially outward therefrom;

means for controlling said jet;

means for guiding a printing medium past said jet;

a tube having an entrance receptive of the ink stored within said container located at the vertex of said container and running along the wall of said container to said jet through which ink may flow from said container to said jet; and

means for rotating said container about its axis at an angular velocity such that the paraboloidal shape of the surface of the ink stored in said container widens less rapidly as a function of height than does the paraboloidal shape of said container.

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