April 21, 1970 J. E. V. JAMES 3,507,583

PUMP FOR LIQUIDS

Filed Oct. 4, 1967

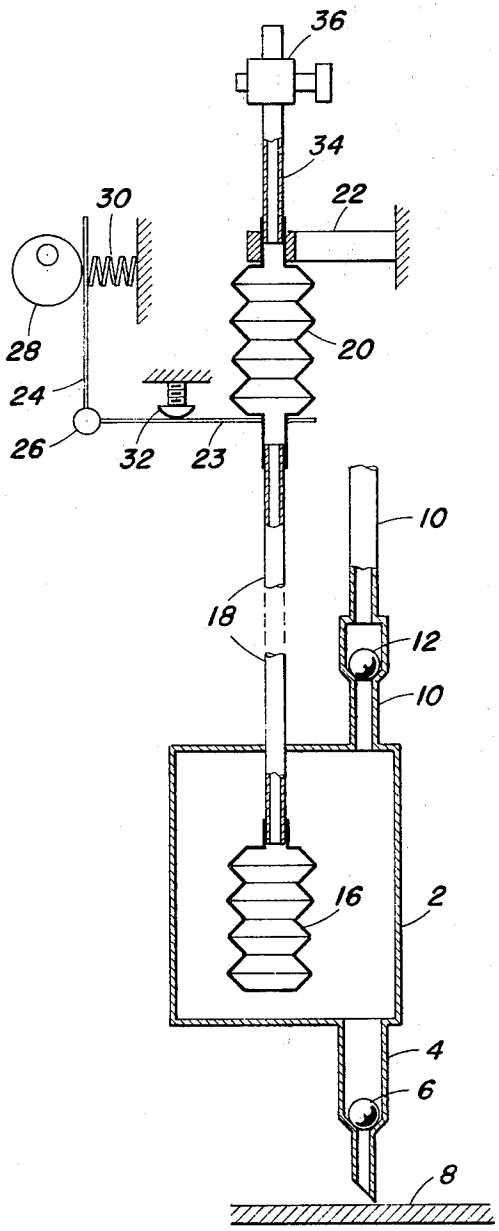

Fig. 1.

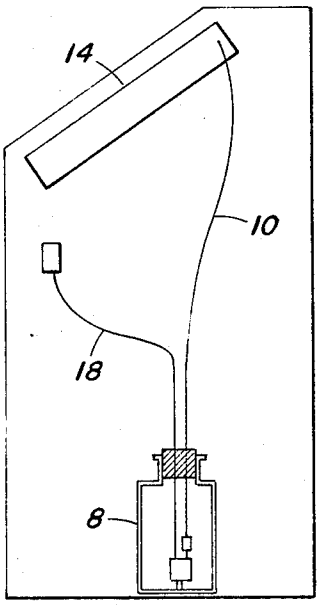

Fig. 2.

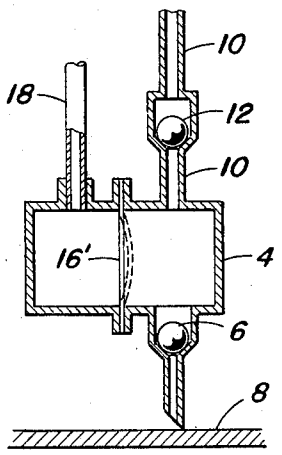

Fig. 3.

INVENTOR.
JOHN E. V. JAMES

BY

Edward H. Loveman

ATTORNEY

United States Patent Office 3,507,583 Patented Apr. 21, 1970

3,507,583

PUMP FOR LIQUIDS

John E. V. James, Totton, England (% General Aniline & Film Corporation, 140 W. 51st St., New York, N.Y. 10020)

Filed Oct. 4, 1967, Ser. No. 672,789
Int. Cl. F04b *17/00;* F42b *5/26*
U.S. Cl. 417—389 1 Claim

ABSTRACT OF THE DISCLOSURE

A displacement pump is provided for submersion in the ammonia liquid bottle or reservoir of ammonia liquor for pumping the liquid ammonia from the reservoir to an elevated evaporator in diazo printing and developing machines, so that vapor lock is avoided. The device includes a slave pump inserted in the liquid and coupled by a conduit to a master pump which is remote from said liquid. The slave pump comprises a hollow expandable and contractile member filled with a fluid supply which is adapted to be withdrawn and supplied thereto by the master pump and thereby change the volume in the bottle or reservoir.

In printing and developing machines using the diazo process it is required ot develop the latent image carried by the sensitized sheet material after exposure, and this may be performed by several methods, the most common being the moist or semi-dry process of development by liquid application, or by the dry or ammonia gas process of development. In the latter, the ammonia may be introduced into the development apparatus in the form of an anhydrous gas, or the required ammonia gas may be generated either within or external to the development apparatus by heating aqueous ammonia liquor which is a solution of ammonia gas in water.

In constructing such machines using aqueous ammonia liquor it is a usual requirement to position the supply bottle or reservoir in the lower portion of the machine for reasons of convenience and safety and to pump the liquor to the evaporating means which is usually situated in the upper portion of the machine. A common arrangement of this kind as hitherto employed in a diazo printing and development machine comprises a pump embodying a bellows or diaphragm driven by a cam actuated mechanism which may be continuously driven or intermittently driven, and may embody means for varying the length of the stroke or the speed of the cam or the frequency or period of operation so as to control the delivery of ammonia liquor automatically or manually to suit the speed of passage and chemical characteristics of the exposed sensitized sheet material to be developed. The inlet to the pump is connected to the ammonia supply bottle or reservoir by a conduit including a non-return valve.

One of the problems of pumping such a liquid as aqueous ammonia liquid is that if the liquid is subjected to partial vacuum, heat or agitation, the gas tends to be released and the system may fail to function properly because of an accumulation of gas in the conduit between the ammonia supply bottle or reservoir and the pump and the inlet valve. This condition is known as a gas lock. Gas locking tends to occur in machines operated at high altitudes, in hot climates and when strong ammonia liquor is used. Because of this difficulty liquor of higher specific gravity may have to be employed. Gas locking tends to occur when the machine is operated at high speed because of the agitation of the liquor by the pumping action. Gas locking also tends to occur at low speeds or pumping because the column of liquor supported below

the pump has time to gas off under the reduced pressure within the conduit.

Therefore, in accordance with the present invention there is provided, a displacement pump for insertion in a supply bottle or reservoir which includes a chamber, non-return inlet and outlet valves to said chamber, a hollow expandable and contractile member in said chamber and means for causing said member to expand and contract, said means including a master pump for supply and withdrawing of fluid to and from said expandable and contractile member, whereby the contents of the reservoir are drawn into the chamber through the non-return inlet valve and discharged through the non-return outlet valve. The master pump may also include a second hollow expandable and contractile member, the expandable and contractile members being coupled by a fluid conduit to form a closed system, whereby any change in volume produced in the master member produces an inverse and corresponding change in the volume of the first or slave member.

Accordingly, it is a primary object of the present invention to provide an improved pumping apparatus for diazo machines which prevents the formation of a gas lock.

Another object of the invention is to provide a pumping apparatus which improves the reliability of ammonia developing machines.

Still another object of the invention is to provide improved pumping apparatus which permits a large freedom of choice as to the relative positions of reservoir and pump in a diazo printing machine.

These and other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which:

FIG. 1 is a diagrammatic part sectional view of one form of a pump made in accordance with the present invention;

FIG. 2 is a diagrammatic sectional view of a diazo printing and development machine showing the general arrangement to a reduced scale of the pump and associated parts involved in the use of ammonia liquor and omitting those parts of the machine not necessary to understanding the working of the present invention; and

FIG. 3 is a diagrammatic section of an alternative form of an expandable and contractile member embodying a diaphragm instead of a bellows.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIGS. 1 and 2 a chamber **2** which has at its base an inlet pipe **4**, fitted with a non-return ball valve **6**, the end of the inlet pipe **4** being cut off at an angle to prevent its terminal aperture **4***a* being occluded by contact with the interior of the base of a bottle **8**, of which only a small fragment is shown. If desired, a filter (not shown) may be positioned between the ball valve **6** and the terminal aperture **4***a*. At the top of the chamber **2** is an outlet pipe **10**, in which is located another non-return ball valve **12**.

As will be seen in FIG. 2, the outlet pipe **10** extends upwards to the ammonia developing tank where the liquor is heated to drive off the ammonia gas in known manner, and brought into contact with the exposed sensitized diazo coated sheet material bearing the latent image which is to be developed. Within the chamber **2** is a bellows **6**, constituting the expandable and contractile member of the slave unit, and this is connected by a conduit **18**, sealed into the top **2***a* of the chamber **2**, and connected at its upper end to the base **20***a*, of a second or master bellows **20** which is rigidly supported at its

upper end **20***b* by a bracket **22**. The base **20***a* of the master bellows **20** rests on one arm **23** of a bell crank lever **24**, which is pivoted at **26**, the other arm of which is shown in contact with a cam **28** and a return spring **30**. An adjustable abutment **32** is positioned above the arm **23** to limit the stroke and thereby the displacement volume of the master bellows **20**. Note that the relative positions of the cam **28** and the spring **30** may be reserved in order to make the compression of the master bellows **20** more positive. If this is done, then the adjustable abutment **32** must be moved to the opposite face of the arm **23**. Note that the adjustable abutment **23** can alternatively be arranged to contact the other arm of the lever **24**. The upper end of the master bellows **20** is connected to a filling pipe **34**, fitted with a cock **36**, which is used for filling the two bellows and interconnecting conduit **18** with distilled water or other inert liquid and for replacing any loss.

An alternative construction is shown in FIG. 3 where the chamber **2** is formed in two parts between which is secured a diaphragm **16***a*. The master bellows **20** could be replaced by a similar diaphragm device provided with an operating rod or cam connected to or bearing upon such diaphragm.

In operation, the rotation of the cam **28** causes a reduction in the volumetric capacity of the master bellows **20**, and the water displaced expands the slave bellows **16**, so that ammonia liquor in chamber **2** is forced up the pipe **10** to the developing tank **14**. Further rotation of the cam **28** permits the return of the lever **24** under the action of the spring **30** aided by the elasticity of the master bellows **20** and slave bellows **16**, permitting the original water volume to be restored in the master bellows **20** due to the elastic contraction of slave bellows **16** and to a lesser extent by the elastic expansion of the master bellows **20**, thus drawing ammonia liquor into the chamber **2** and the pumping cycle may be repeated for every rotation of the cam **28**. The elastic effect of the master bellows **20** and slave bellows **16** may be augmented by the use of springs. The cam **28** may be fitted with two or more lobes to give an increased number of pumping cycles per revolution of the cam driving means. Adjustment of the average quantity pumped per unit of time may be varied by automatic or manual adjustment of the abutment **32** which restricts the return movement of the lever **24**, or by varying the speed of rotation of the cam **28**, or by operating the cam driving means intermittently or for varying periods of the driven and non-driven states.

With the arrangement above described, the ammonia liquor is pumped under pressure so that gassing off due to the pumping action is minimized and gas locking is avoided. This is particularly important if the diazo printing and developing machine is used at high altitude or in a high ambient temperature as may be met in hot climates or in heated locations. The device also permits the use of ammonia liquor at stronger concentration than was practicable hitherto, and in the design of such machines the employment of the device will permit the ammonia bottle or reservoir and the pump and ammonia tank to be each located within the machine with greater choice of position and dimensions between them than was practicable hitherto.

It should also be understood that the foregoing relates to only a preferred embodiment of the invention, and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention.

What is claimed is:

1. In the combination of a diazo copying machine having a developing section to which is pumped ammonia and other liquids for vaporization, the improvement comprising a pumping apparatus for pumping liquid ammonia from a closed renewable bottle type reservoir to a vaporizer of said developing section including:

a chamber having a non-return liquid ammonia inlet valve and a non-return liquid ammonia outlet valve;

a hollow expandable, contractible member positioned within said chamber; and

remote means for causing said hollow member to expand and contract, said remote means including tubing extending through a closure member in said bottle and a master pump for supplying another liquid to and withdrawing such liquid from said hollow member by way of said tubing whereby liquid in said bottle is drawn into said inlet valve and forced out of said outlet valve to said developing section.

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ROBERT M. WALKER, Primary Examiner

U.S. Cl. X.R.

60—54.5; 417—385, 395