PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION

Improvements in and relating to Reservoir Writing Instruments

I, HENRY GEORGE MARTIN, a British Subject, of Avenida Roque Saenz Pena 547, Buenos Aires, Argentine, do hereby declare the nature of this invention to be as follows:—

This invention concerns reservoir writing instruments or pens of the ball tip type wherein the writing extremity or nib comprises a ball rotatably housed in and partly protruding from a socket or housing which ball is supplied with ink from a reservoir consisting of an attenuated duct or vein which extends between an air vent and the base of the socket or housing so that, as the ball is rotated by being moved over and in contact with a surface such for example as that of a sheet of paper, a thin film of ink is carried by the ball through the narrow gap between it and its housing and is deposited as a trace on said surface. It is to be pointed out that whereas capillary forces are often relied upon to draw a liquid up a capillary tube, in a pen of the type specified capillary forces are used to maintain ink in the duct.

A meniscus is formed at the interface between liquid, air and duct walls and its formation is a function of surface tension. In all oleaginous inks suitable for use in ball tip writing instruments of the type specified, the surface tension, irrespective of viscosity, is substantially similar. Viscosity has no bearing on capillarity. The essential function of viscosity is that it delays the break-up of this meniscus (and also delays the breaking of the film on the exposed part of the ball). This will readily be appreciated from the following. If a tube of given diameter is filled with a non-viscous liquid and is subjected to shock the meniscus breaks comparatively easily and the liquid will flow out of the tube. On the other hand, if the same tube is filled with a liquid of substantial viscosity and is subjected to the same shock the viscosity will function to delay the break up of the meniscus possibly for a sufficiently long period to prevent the liquid running out of the tube.

It has been ascertained that if the diameter of the duct is less than 2.4 mm. the viscosity of the ink is relatively unimportant insofar as delay in or prevention of the break-up of the meniscus is concerned. This is because the capillary forces in such a duct are so strong that irrespective of the viscosity the meniscus will not be easily broken and the ink will not run out of the duct upon such shocks as the pen may normally experience in use. On the other hand, if the size of the duct is increased beyond 2.4 mm. the question of viscosity becomes of considerable importance and it has been ascertained that for a given size of duct there is a definite minimum viscosity value for the ink. The ink should have this viscosity at all temperatures that the reservoir attains in normal use, but since viscosity decreases with rise in temperature this practical requirement is met if the ink has the required viscosity at the maximum temperature likely to be attained by the reservoir in normal use.

The relationship between duct size and minimum viscosity is shown in the attached graph, and the present invention provides in or for a writing instrument of the type specified a reservoir which is characterised in that, in relation to the duct diameter, the viscosity of the ink at the maximum temperature likely to be attained by the reservoir in normal use, is not less than, or not appreciably less than that shown on the attached graph. It may here be explained that while practical manufacturing considerations will in many instances render it desirable that the duct shall be circular in cross section, yet in other instances manufacturing conditions will render it

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unavoidable, that the duct shall not be truly circular in cross section. Therefore the expression " diameter " is employed herein to include the diameter of a circle that approximates to the cross-sectional size and configuration of the duct when the latter is not truly circular.

It is further to be pointed out that the temperature attained by the reservoir in normal use will depend upon the climate in which the instrument is used. Therefore, inks of differing viscosities are to be employed according to the climate in which it is intended that the reservoir shall be used. By way of example, the constitutions of three inks suitable for a reservoir having a duct size of not more than 3 mm. and intended for arctic temperate and tropical climates respectively are given below:—

ARCTIC INK.

	Parts by weight
Colophony	25
Castor oil	20
Ricinoleic acid	20
Diethylene glycol mono-butyl ether	20
Oil soluble dyes	15

Viscosity at 15° C.: 23 poise

TEMPERATE CLIMATE INK

	Parts by weight
Colophony	25
Castor oil	30
Ricinoleic acid	30
Oil soluble dyes	15

Viscosity at 15° C.: 230 poise

TROPICAL INK.

	Parts by weight
Colophony	35
Castor oil	25
Ricinoleic acid	25
Oil soluble dyes	15

Viscosity at 15° C.: 470 poise

It will be seen that the foregoing inks consist of a solvent (which is characterised by low vapour pressure relative chemical stability to oxidation and polymerisation, and good lubricating properties), a thickener (being a resin which may be either a naturally occurring or a synthetically prepared resin) and dye soluble in the solvent and compatible with the thickener (the dye may be an organic, and preferably an aniline, dye).

Dated this 30th day of January, 1947.

ERIC POTTER & CLARKSON,
Chartered Patent Agents.

COMPLETE SPECIFICATION

Improvements in and relating to Reservoir Writing Instruments

I, HENRY GEORGE MARTIN, a British Subject, of Avenida Roque Saenz Pena 547, Buenos Aires, Argentine, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention concerns reservoir writing instruments or pens of the ball tip type wherein the writing extremity or nib comprises a writing ball rotatably housed in and partly protruding from a socket or housing which ball is supplied with ink from a reservoir consisting of a duct or vein which extends between an air vent and the base of the socket or housing so that, as the ball is rotated by being moved over and in contact with a surface such for example as that of a sheet of paper, a thin film of ink is carried by the ball through the narrow gap between it and its housing and is deposited as a trace on said surface. Such an instrument is described and claimed in Letters Patent No. 573,747, and in the Complete Specification of co-pending Patent Application Serial No. 629,283.

In such an instrument a meniscus is formed in the duct at the end of the ink column or vein remote from the ball at the interface between liquid, air and duct walls and its formation is a function of surface tension. The surface tension of all oleaginous inks suitable for use in ball tip writing instruments of the type specified is substantially similar, irrespective of the viscosity. Though viscosity has no bearing on surface tension, its essential function is to delay the breakng up of this meniscus (and of the film on the exposed part of the ball). This will readily be appreciated from the following. If a tube of small diameter is filled with a liquid of low viscosity and is subjected to shock, the meniscus breaks comparatively easily and the liquid will flow out of the tube. On the other hand, if the same tube is filled with a liquid of high viscosity and is subjected to the same shock the high viscosity, presenting a strong resistance to relative movement within the liquid, prevents the break up of the meniscus so that no liquid will run out of the tube.

It has been ascertained that with decreasing diameter of the duct lower

viscosities of the ink are sufficient to delay or prevent the break-up of the meniscus. This is because the capillary forces in small ducts are so strong that even at low viscosities the meniscus will not be easily broken and the ink will not run out of the duct upon such shocks as the pen may normally experience in use. For example, the meniscus of an ink with 1 to 10 poise viscosity is perfectly safe in a vented reservoir duct between 2 and 2.5 m.m. in diameter. On the other hand, if the size of the duct is increased beyond 2.5 m.m. the question of viscosity becomes of considerable importance and it has been ascertained that for a given size of duct the viscosity of ink must be increased beyond a minimum value in order to be safe. The viscosity of the ink should be equal to or higher than such minimum value at all temperatures that the reservoir attains in normal use, but since viscosity decreases with rise in temperature this practical requirement is met if the ink has the required viscosity at the maximum temperature likely to be attained by the reservoir in normal use.

The relationship between duct size and minimum viscosity which will prove reasonably satisfactory from a commercial point of view in pens that are subjected to normal use, is shown in the graph accompanying the Provisional Specification and the present invention provides a method of producing a filled reservoir for reservoir writing instrument of the type specified, which consists in estimating the maximum temperature to be attained by the reservoir in normal use in the conditions in which the instrument is intended to be used, constructing a reservoir having an internal diameter not less than 2.5 m.m. or not more than 4 m.m. or equivalent sectional area and filling the reservoir with an ink the viscosity of its meniscus-forming part at such maximum temperature being not less than or not appreciably less than that shown in the graph accompanying the Provisional Specification, in relation to the internal diameter of the reservoir. The invention also provides in or for a reservoir writing instrument of the type specified a reservoir which is characterised in that in relation to the duct size, the viscosity of the meniscus-forming part of its contents at 30° C. is not less than, or not appreciably less than that shown on the graph accompanying the Provisional Specification. It may here be explained that while practical manufacturing considerations will in many instances render it desirable that the duct shall be circular in cross section, yet in other instances manufacturing conditions will render it unavoidable that the duct shall depart slightly in cross section from the truly circular. The expression "diameter" is employed herein to include the diameter of a circle that approximates to the cross-sectional size and configuration of the duct when the latter departs slightly in cross section from the truly circular. If the cross-sectional shape of the duct departs radically from the truly circular, its width in one direction being appreciably greater than its width in a direction transverse thereto (as for example in the case of a duct of oval or similar sectional shape) the expression "diameter" is employed herein, in relation to such a duct, to mean the diameter of a circle the area of which is equal to the area of such a duct.

The expression "meniscus-forming part" is employed herein to mean that portion of the contents of the reservoir which forms the meniscus before discussed. It is preferred that the viscosity of the ink shall not be appreciably greater than 150 poise at the maximum temperature likely to be attained in normal use; from this it follows that the maximum diameter of reservoir that may be charged with such an ink is in the order of 3.8 m.m.

It is further pointed out that the temperature attained by the reservoir in normal use will depend upon the climate in which the instrument is used. Therefore, inks of differing viscosities are to be employed according to the climate in which it is intended that the reservoir shall be used. By way of example, the constitutions of three inks suitable for a reservoir having a duct size of not more than 3 m.m. and intended for arctic, temperate, and tropical climates respectively are given below:—

ARCTIC INK.

	Parts by weight
Colophony	25
Castor oil	20
Ricinoleic acid	20
Diethylene glycol mono-butyl ether	20
Oil soluble dyes	15

Viscosity at 15° C.: 18—30 poise.

TEMPERATE CLIMATE INK

	Parts by weight
Colophony	25
Castor oil	30
Ricinoleic acid	30
Oil soluble dyes	15

Viscosity at 15° C.: 190—300 poise.

TROPICAL INK.

	Parts by weight
Colophony	35
Castor oil	25
Ricinoleic acid	25
Oil soluble dyes	15

Viscosity at 15° C.: 400—600 poise.

It will be seen that the foregoing inks consist of a solvent (which is characterised by low vapour pressure, relative chemical stability to oxidation and polymerisation, and good lubricating properties), a thickener (being a resin which may be either a naturally occurring or a synthetically prepared resin) and dye soluble in the solvent and compatible with the thickener (the dye may be an organic, and preferably an aniline dye). The viscosity in each case varies over a range by reason of possible variations in the character of the constituent materials, notably the colophony.

The figure accompanying the Provisional Specification (hereinafter called the Provisional Figure) shows the graph herein referred to, and the accompanying drawing shows, mainly in longitudinal section a reservoir writing instrument according to this invention.

In the graph shown in the Provisional Figure the duct diameter, in millimeters, is plotted horizontally and the viscosity in poise is plotted vertically.

The accompanying drawing illustrates a writing instrument of the type specified. It comprises a writing extremity 1 which houses a ball 2 and is connected to a tubular reservoir 3. This reservoir communicates with the gap between the ball and its housing by means of a small-diameter feed duct. The said gap and feed duct are not illustrated since they are well understood by those familiar with the construction of writing instruments of the type specified. It may be mentioned, however, that the ball is desirably in the order of 1 m.m. in diameter, the diameter of the feed duct at that end thereof which communicates with the ball housing is less than that of the ball, and the width of the gap is preferably between 1×10^{-4} and 1×10^{-3}.

The unit, consisting of the writing extremity 1 and the reservoir 3, is housed in a casing consisting of a barrel 4 provided with an air hole 5 and an adaptor 6. Conveniently, but not necessarily the writing extremity is screwed into the adaptor 6 and 7 and said adaptor are screwed together at 8. A cap, not shown, may be provided which when the instrument is not in use screws onto the casing at 13 to protect the writing extremity and which, when the instrument is in use, is fitted over the other end of said instrument.

It will be observed that the rear end 9 (i.e. that end which is remote from the ball 2) of the tubular reservoir 3 is open so that the contents of the reservoir are exposed to atmospheric pressure at this end. However, the said contents are prevented from flowing out at the open end by reason of the meniscus 10 which is there formed at the interface between said liquid, the air, and the interior surface of the walls of the reservoir.

The viscosity of this meniscus-forming liquid bears the minimum relationship to the internal diameter of the reservoir, at all temperatures that the reservoir attains in normal use, that is shown in the graph (Provisional Figure) and this ensures that the meniscus is sufficiently strong to withstand rupture under normal conditions of use.

What we claim is:—

1. A method of producing a filled reservoir for a reservoir writing instrument of the type specified, which consists in estimating the maximum temperature to be attained by the reservoir in normal use in the conditions in which the instrument is intended to be used, constructing a reservoir having an internal diameter not less than 2.5 m.m. or not more than 4 m.m. or equivalent sectional area and filling the reservoir with an ink the viscosity of its meniscus-forming part at such maximum temperature being not less than or not appreciably less than that shown in the graph, accompanying the Provisional Specification, in relation to the internal diameter of the reservoir.

2. In or for a reservoir writing instrument of the type specified a reservoir which is characterised in that in relation to the duct size, the viscosity of the meniscus-forming part of its contents at 30° C. is not less than, or not appreciably less than that shown on the graph accompanying the Provisional Specification.

3. A method according to Claim 1, or apparatus according to Claim 2, wherein the viscosity of the ink does not exceed 150 poise at 30° C. and the diameter of the reservoir is not greater than 3.8 m.m.

4. A method according to Claim 1 or Claim 3, or apparatus according to Claim 2 or Claim 3, wherein the ink consists of a solvent which is characterised by low vapour pressure, relative chemical stability to oxidation and polymerisation; a thickener and a dye soluble in the solvent and compatible with the thickener.

5. A filled reservoir for a reservoir writing instrument of the type specified, produced by the method claimed in Claim 1.

and barrel

TROPICAL INK.

	Parts by weight
Colophony	35
Castor oil	25
Ricinoleic acid	25
Oil soluble dyes	15

Viscosity at 15° C.: 400—600 poise.

It will be seen that the foregoing inks consist of a solvent (which is characterised by low vapour pressure, relative chemical stability to oxidation and polymerisation, and good lubricating properties), a thickener (being a resin which may be either a naturally occurring or a synthetically prepared resin) and dye soluble in the solvent and compatible with the thickener (the dye may be an organic, and preferably an aniline dye). The viscosity in each case varies over a range by reason of possible variations in the character of the constituent materials, notably the colophony.

The figure accompanying the Provisional Specification (hereinafter called the Provisional Figure) shows the graph herein referred to, and the accompanying drawing shows, mainly in longitudinal section a reservoir writing instrument according to this invention.

In the graph shown in the Provisional Figure the duct diameter, in millimeters, is plotted horizontally and the viscosity in poise is plotted vertically.

The accompanying drawing illustrates a writing instrument of the type specified. It comprises a writing extremity 1 which houses a ball 2 and is connected to a tubular reservoir 3. This reservoir communicates with the gap between the ball and its housing by means of a small-diameter feed duct. The said gap and feed duct are not illustrated since they are well understood by those familiar with the construction of writing instruments of the type specified. It may be mentioned, however, that the ball is desirably in the order of 1 m.m. in diameter, the diameter of the feed duct at that end thereof which communicates with the ball housing is less than that of the ball, and the width of the gap is preferably between 1×10^{-4} and 1×10^{-3}.

The unit, consisting of the writing extremity 1 and the reservoir 3, is housed in a casing consisting of a barrel 4 provided with an air hole 5 and an adaptor 6. Conveniently, but not necessarily the writing extremity is screwed into the adaptor 6 and 7 and said adaptor are screwed together at 8. A cap, not shown, may be provided which when the instrument is not in use screws onto the casing at 13 to protect the writing extremity and which, when the instrument is in use, is fitted over the other end of said instrument.

It will be observed that the rear end 9 (i.e. that end which is remote from the ball 2) of the tubular reservoir 3 is open so that the contents of the reservoir are exposed to atmospheric pressure at this end. However, the said contents are prevented from flowing out at the open end by reason of the meniscus 10 which is there formed at the interface between said liquid, the air, and the interior surface of the walls of the reservoir.

The viscosity of this meniscus-forming liquid bears the minimum relationship to the internal diameter of the reservoir, at all temperatures that the reservoir attains in normal use, that is shown in the graph (Provisional Figure) and this ensures that the meniscus is sufficiently strong to withstand rupture under normal conditions of use.

What we claim is:—

1. A method of producing a filled reservoir for a reservoir writing instrument of the type specified, which consists in estimating the maximum temperature to be attained by the reservoir in normal use in the conditions in which the instrument is intended to be used, constructing a reservoir having an internal diameter not less than 2.5 m.m. or not more than 4 m.m. or equivalent sectional area and filling the reservoir with an ink the viscosity of its meniscus-forming part at such maximum temperature being not less than or not appreciably less than that shown in the graph, accompanying the Provisional Specification, in relation to the internal diameter of the reservoir.

2. In or for a reservoir writing instrument of the type specified a reservoir which is characterised in that in relation to the duct size, the viscosity of the meniscus-forming part of its contents at 30° C. is not less than, or not appreciably less than that shown on the graph accompanying the Provisional Specification.

3. A method according to Claim 1, or apparatus according to Claim 2, wherein the viscosity of the ink does not exceed 150 poise at 30° C. and the diameter of the reservoir is not greater than 3.8 m.m.

4. A method according to Claim 1 or Claim 3, or apparatus according to Claim 2 or Claim 3, wherein the ink consists of a solvent which is characterised by low vapour pressure, relative chemical stability to oxidation and polymerisation; a thickener and a dye soluble in the solvent and compatible with the thickener.

5. A filled reservoir for a reservoir writing instrument of the type specified, produced by the method claimed in Claim 1.

and barrel

6. Apparatus according to Claim 4 or Claim 5 wherein the ink has the constitution specified in any of the three examples given in the accompanying description.

Dated this 25th day of July, 1947.

ERIC POTTER & CLARKSON,
Chartered Patent Agents.

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