SPECIFICATION

Syringe

The invention relates to a syringe of the kind comprising a hollow rotationally symmetrical barrel which is open at both ends, a plunger which is movable in said barrel and seals same, a stopper whose dimensions are such that it can be provided in the aperture present on the front side of the barrel in a sealing manner, and a needle holder consisting of a collar provided on the front side of the barrel in a sealing manner, a neck in which or to which an injection needle is or can be provided in a sealing manner, the rear side of the needle not projecting beyond the rotationally symmetrical rear face of the neck, and a hollow, internally cylindrical shaft which connects the collar and the neck in a sealing manner.

A syringe, of the aforesaid kind, and which is particularly intended for transport and storage purposes whilst filled with a liquid medicament and for single dosage use only, is disclosed in United States Patent Specification 3,941,128. The syringe described in said Patent Specification comprises a cylindrical barrel which, viewed in the direction in which the liquid is to be injected, comprises a fingergrip on the rear side and on the front side debouches into a kind of nozzle the inside diameter of which is considerable smaller than that of the remainder of the barrel. On said nozzle the collar of a needle holder is secured on the outside, which collar is connected, *via* a hollow internally cylindrical shaft, to a needle neck in which an injection needle is secured. The cannula of the injection needle debouches on the rear side into the space enclosed by the rear wall of the neck and the inner wall of the shaft.

A stopper in the nozzle closes the nozzle completely. In the centre said stopper has a circular cross-section through the nozzle but tapers at the front and rear ends and in addition comprises recesses there so that the front and the rear ends of the stopper are cross-shaped in cross-section.

When said syringe which is filled with liquid medicine is to be used, a slight pressure is exerted on the plunger *via* a plunger rod so that the stopper is moved forward from the nozzle and lands in the space enclosed by the shaft and the neck of the needle holder. When the plunger is further moved forward and the syringe is held with the injection needle uppermost, the air will be expelled from the syringe. The injection needle can now be inserted into the patient and the liquid medicine present in the syringe is the injected into the patient by further forward movement of the plunger. As a result of the tapering cross-shaped ends of the stopper it is ensured that said stopper will not clog the entrance to the cannula upon deaerating the syringe and upon injecting the liquid medicine.

It is known that a liquid in a pre-filled syringe on the front side can be sealed by means of a diaphragm which is to be perforated prior to using the injection needle. The disadvantage of such a construction, however, is that during the perforation small particles of the diaphragm can be cut out which may then clog the injection needle or enter the body of the patient.

This problem is avoided by constructing the syringe so that the diaphragm bursts by pressure. However, such a construction has the disadvantage that sometimes a considerable pressure has to be exerted to produce the bursting of the diaphragm, which may result in premature driving out of the injection liquid. The above-described syringe according to United States Patent Specification 3,941,128 does not exhibit the said disadvantages because no diaphragm is present in said syringe there being used a stopper which is removed entirely from an aperture.

Sealing the barrel of a syringe on the front side by means of a stopper which has to be removed prior to using the syringe has also been suggested before. In some constructions the stopper, viewed in the direction in which the liquid is to be injected, has to be removed in a rearward direction from a closed aperture, either by pressing the injection needle or by moving the plunger rearwards (see for example, United States Patent Specification 2,798,487). Simpler, and for that reason to be preferred, are syringes which are constructed so that the removal of the stopper is carried out by moving the plunger in the same direction in which it has to be moved afterwards for deaerating the syringe and for administering the injection. Such syringes are disclosed, for example, in the above-cited United States Patent Specification 3,941,128.

However, all the syringes suggested so far in which the barrel is closed by a stopper at the front end, and hence also the above-described syringe according to United States Patent Specification 3,941,128, have the disadvantage that behind the rear end of the injection needle is a space for receiving the stopper, which space is filled only partly by the stopper so as to enable the passage of air and liquid. After administering the injection, a rather large amount of liquid remains in said so-called dead space, the liquid being discarded together with the syringe. In particular in small syringes and/or expensive liquid medicines, said dead space results in a considerable loss of expensive medicine.

An additional disadvantage of the already suggested syringes equipped with a closing stopper is that they are complicated in shape and therefore the costs of manufacture are high; this applies in particular to the stopper from the above-mentioned United States Patent Specification 3,941,128. This is the more important because previously filled syringes are manufactured in large numbers and therefore a small increase of the costs for a syringe involves already large amounts. Another disadvantage of a complicated shape of components of syringes is that these are difficult to clean before assembly so that the possibility of contamination of the injection liquid is increased.

This applies in particular to the rubber components, such as plunger and stopper. As a matter of fact, rubber components are manufactured by cutting or punching so that said components always contain rubber particles. In contrast herewith, plas-

tics components for this application are usually manufactured in dust-free circumstances (injection moulding), so that no separate plastics particles or dust particles are present.

It is the object of the invention to provide a syringe having a small dead space but a low resistance to flow of liquid during injection, and a comparatively thick closing stopper so that little diffusion will occur, and components of a simple shape so that the cost of manufacture can be kept low.

This object can be achieved with a syringe of the aforesaid kind which is characterized in that the barrel has the shape of a hollow cylinder, that the stopper has the shape of a cylinder whose outside diameter is slightly larger than the inside diameter of the barrel, that the inner wall of the shaft and the rear face of the neck comprise one or more slots extending from the rear edge of the shaft to the rear end of the injection needle or the neck aperture, and that the space bounded by the inner wall of the shaft and the rear face of the neck, apart from the said slot or slots, has the same rotationally symmetrical but slightly longer shape than the stopper and approximately the same diameter as the inside diameter of the barrel, so that the stopper can fill said space substantially entirely but does not cover the part of the said slot or slots adjoining the barrel. The rearward directed end face of the stopper and the front face of the plunger are preferably both rotationally symmetrical and complementary.

A further surprising aspect of the syringe is that it is particularly suitable for a construction in two parts. The first part is formed by the barrel with medicine in which the stopper and the plunger are provided and which, if desired, already has a finger grip and/or plunger rod, the second part of the syringe is formed by the needle holder or shaft and the needle connected thereto.

This construction in two parts has several advantages. For example, it is possible in this case to provide the user separately with needle holder with needles of different dimensions, so that he can select the correct needle for each individual case. The barrel with medicine which is also supplies separately is the only part of the syringe which (often) is restricted to a date of keepability and/or is to be subjected to a special treatment, for example post-sterilization, storage in the dark and/or while cooling. This is not only of advantage from a point of view of production but is also of importance for a more economical production method of the syringes.

In this construction in two parts the needle holder can be secured to the barrel in a simple manner, for example, by pressing the needle holder on the barrel (snap-cap construction) or screwing it on the barrel in the case of a screw or bayonet joint. In this embodiment the syringe can also be packaged more easily because the separate parts are shorter. In addition, the sterilization of said individual parts is simpler, while also the expensive assembly in a sterile space can be reduced by one operation. Of course, the diameter and the connection means of needle holder and barrel should be matched to each other.

Besides for the adminstration of an injection, the syringe embodying the present invention may also be used for dosing infusion liquids. In that case the needle holder is provided with a cap or shield, as described, for example, in United States Patent Specification 4,031,890. As a result of this it is prevented that the syringe will be used for an intravenous injection. The same safety is obtained by using, instead of a cap or shield around the needle holder, a thick plastics needle which is not suitable for an injection. In the above-mentioned application a second safety is usually ensured, namely aspiration is made impossible. This safety is achieved, for example, by not providing the plunger with a connection means for the plunger rod. In the embodiment according to the present invention, the plunger may be identical to the stopper. In such an embodiment which is, of course, suitable only for infusion liquids, the barrel provided with stopper and plunger is entirely symmetrical, which facilitates the assembly.

The needle holder of the syringe according to the present invention is also excellently suitable for use in so-called two-chamber-syringes. For example, the syringe according to the invention, filled with a solvent for the medicament to be injected, may be detachably connected, by means of a telescopic assembly, to a vial containing the medicament; such a two-chamber-syringe is disclosed, for example, in Applicants' Netherlands Patent Application 7,412,096. It will be obvious that the needle holder of the syringe according to the invention may also be used in two-chamber-syringes of a construction different from that described above.

Embodiments of the invention will now be described in greater detail with reference to preferred embodiments shown in the drawings, in which

Figure 1 is a longitudinal sectional view of a syringe in a condition in which it can be transported and stored,

Figure 2 shows the syringe of Figure 1 in a condition in which it is ready for adminstering an injection,

Figure 3 is a cross-sectional view through the needle holder of the syringe shown in the preceding Figures, taken on the line III-III of Figure 1, viewed in the direction of the needle, and

Figures 4, 5 and *6* are longitudinal sectional views of other embodiments of the invention.

The syringe shown in Figure 1 comprises a barrel 11, in which a plunger 12 is provided on one side while the other side comprises an injection needle 13 surrounded by a needle-guard 14.

The plunger can be moved by means of a plunger rod 15 which can be secured to the plunger, for example, by screwing. At the same end where the plunger is situated, the barrel has a fingergrip 16 which is secured to the barrel according to the so-called snap-cap principle. Another likewise reliable connection of a finger grip is disclosed in British Patent Specification 1,479,536 in the name of Applicants; the finger-grip described in said specification comprises a compressible coller which is clamped around the end of the barrel by means of a tightening sleeve. The fingergrip preferably consists of slightly resilient material, for example plastics.

The barrel is manufactured from a rigid material, preferably glass. In another embodiment the finger-grip is a flangelike part of the barrel projecting radially outwards. Of course, other construction known to those skilled in the art are possible.

A stopper 17 closing the barrel is situated in the end of the barrel remote from the plunger. The plunger and the stopper are manufactured from resilient material, preferably rubber of a pharmaceutical quality.

The injection needle 13 is secured to the barrel by means of a needle holder 18. The needle holder has a neck 19 which holds the needle, a shaft 20 and a collar 21. The needle holder is preferably manufactured from slightly resilient material which, however, has sufficient resistance to deformation, for example, plastics, and is secured to the end of the barrel by means of a snap-cap construction. In another embodiment the needle holder may be secured to the barrel by means of a screwed connection or, when the barrel also comprises a collar, by means of a clamping ring; in the latter embodiment the needle holder may also be flanged around the collar of the barrel.

One or more slots 22 are recessed in the inner wall of the shaft and the rear face of the neck. This is shown in detail in Figure 3 which is a cross-sectional view through the shaft of the needle holder taken on the line III-III of Figure 1 viewed in the direction of the needle. Arbitrarily one slot is shown in Figure 3 but more slots may be recessed in the needle holder. The slot or slots debouch into the rear end of the cannula. In cross-section the slots may be parts of a circle, as shown in Figure 3, but other shapes are also possible, provided the size is such that the injection liquid can sufficiently readily be passed through; this is achieved by choosing the diameter of the slot or the overall cross-section of the slots to be at least as large as that of the cannula. The shaft of the needle holder is constructed so that when the stopper slides axially forward, it is received with friction by the shaft; therefore, apart from the slots recessed in the shaft, the inside diameter of the shaft is approximately as large as that of the barrel to be connected to the needle holder. The inside diameter of the shaft preferably is at most equal to that of the barrel, so that during aspiration the stopper cannot be drawn back. Furthermore, the shaft of the needle holder is slightly longer than the stopper so that the part 23 of the slot(s) adjoining the barrel is released when the stopper is moved forward entirely against the rear wall of the neck of the needle holder. This is shown clearly in Figure 1 in which the syringe of Figure 1 has been activated, that is, moved in the position in which it is ready for adminstering an injection. In this position the injection liquid can reach the cannula *via* the slots without any hindrance. If desired, the needle protector may be constructed so as to also serve as a plunger rod. In that case, prior to the administration of an injection, the needle protector is removed from the needle and secured to the plunger on the other side of the syringe.

Generally, the syringe comprising a needle protector moreover has a safety member so that it can easily be established whether the needle protector has already been removed before. Such a safety member in the form of a cap is described, for example, in Applicants' Netherlands Patent Application 7,401,607.

The needle comprises a needle-guard 14 which keeps the needle sterile during storage.

In another embodiment a longitudinal cross-sectional view of which is shown in Figure 4 the needle is provided so as to be eccentric. Such a construction is sometimes desired in syringes having a large barrel diameter.

In another embodiment a longitudinal sectional view of which is shown in Figure 5, the syringe does not comprise a needle in the position in which the syringe is stored. Before use the needle is positioned on the neck 24 of the needle holder by means of a needle hub after having removed the protecting cap (see hereinafter).

A so-called Luer cone is preferably used for this connection. In this embodiment the aperture 25 in the neck of the needle holder is closed on the outside by a protecting cap 26 which ensures the sterility of said part of the needle holder. The above-mentioned slot(s) 22 recessed in the needle holder debouch(es) into the inner end of said neck aperture.

Figure 6 shows the syringe in two parts in a certain embodiment. For example, the needle holder with injection needle shown may also be constructed as a needle holder with a Luer cone; in that case the needle is supplied separately. The connection of needle holder to barrel is shown as a snap-cap construction. Other connection means are also possible, as stated above. In a likewise efficacious construction the barrel comprises at each end a flange projecting radially outwards and forming one assembly with the barrel; on the rear side the flange forms a finger grip, on the front side it forms a connection for the needle holder. In order to facilitate dispensing, the barrel is preferably symmetrical on two sides, as shown in Figure 6. In Figure 6 the finger grip and plunger rod to be provided separately are not shown.

In order to minimize the residual volume of medicine, the end face of the stopper directed rearwardly and the end face of the plunger directed forwardly are both preferably rotationally symmetrical and complementary. In a further preferred embodiment of the syringe, both faces are substantially flat. In addition, the front face of the stopper and the rear face of the neck of the needle holder, apart from the slot or slots recessed in said rear face, are preferably flat surfaces; in this preferred embodiment of the syringe the quantity of medicine remaining in the syringe after the injection also is as small as possible.

The syringe embodying the present invention may also comprise a so-called "final filter" serving to stop "particulate matter", if any, present in the injection liquid. Such a filter will preferably be placed on the rear side in the duct in the neck of the needle holder, for example, in a cavity recessed for this purpose between the needle and the rear face of the neck.

CLAIMS

1. A syringe comprising a hollow rotationally symmetrical barrel which is open at both ends, a plunger which is movable in said barrel and seals same, a stopper the dimensions of which are such that it can be provided in the aperture present in the front side of the barrel so as to be sealing, and a needle holder consisting of a collar provided in a sealing manner to the front side of the barrel, a neck in which or to which an injection needle is or can be provided in a sealing manner, the rear side of the needle not projecting beyong the rotationally symmetrical rear face of the neck, and a hollow internally cylindrical shaft connecting the collar and the neck in a sealing manner, characterized in that
- the barrel has the shape of a hollow cylinder,
- the stopper has the shape of a cylinder whose outside diameter is slightly larger than the inside diameter of the barrel,
- the inner wall of the shaft and the rear face of the neck comprise one or more slots extending from the rear edge of the shaft to the rear end of the injection needle the neck aperture, and
- the space bounded by the inner wall of the shaft and the rear face of the neck, apart from the said slot or slots, has the same rotationally symmetrical but slightly longer shape than the stopper and approximately the same diameter as the inside diameter of the barrel, so that the stopper can fill said space substantially entirely but does not cover the part of the said slot or slots adjoining the barrel.

2. A syringe as claimed in Claim 1, characterized in that
- the end face of the stopper directed rearward and the end face of the plunger directed forward are both rotationally symmetrical and complementary.

3. A syringe as claimed in Claim 1 in which the barrel is filled with a liquid medicament and the front of the barrel is closed by the stopper situated just entirely in the barrel.

4. A needle holder for a syringe as claimed in one or more of the preceding Claims, comprising a collar, a neck having a rotationally symmetrical rear face with therein an aperture for the sealing connection of an injection needle, and a hollow internally cylindrical shaft connecting the collar to the neck in a sealing manner, characterized in that the inner wall of the shaft and the rear face of the neck comprise one or more slots extending from the edge of the shaft adjoining the collar to the lower part of the aperture in the neck destined for the injection needle, and that, apart from the said slot or slots, the inside diameter of the shaft is approximately as large as that of the barrel to be connected to the needle holder.

5. A syringe as claimed in Claim 1 2 or 3, characterized in that the front face of the plunger and the rear face of the stopper are both flat surfaces.

6. A syringe as claimed in Claim 1, 2, 3 or 4, characterized in that the front face of the stopper and the rear face of the neck, apart from the slot or slots recessed in said rear face, are both substantially flat surfaces.

7. A syringe as claimed in any of the Claims 1, 2, 3, 5 or 6, characterized in that it comprises a needle holder, which may or may not be provided with an injection needle, and a separate barrel to be connected to the needle holder, the said barrel having a stopper, a plunger to which a plunger rod is or can be connected and a finger grip or means for the connection thereof.

8. A syringe as hereinbefore described with reference to Figures 1 to 3 or 4, 5 or 6 of the accompanying drawings.

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