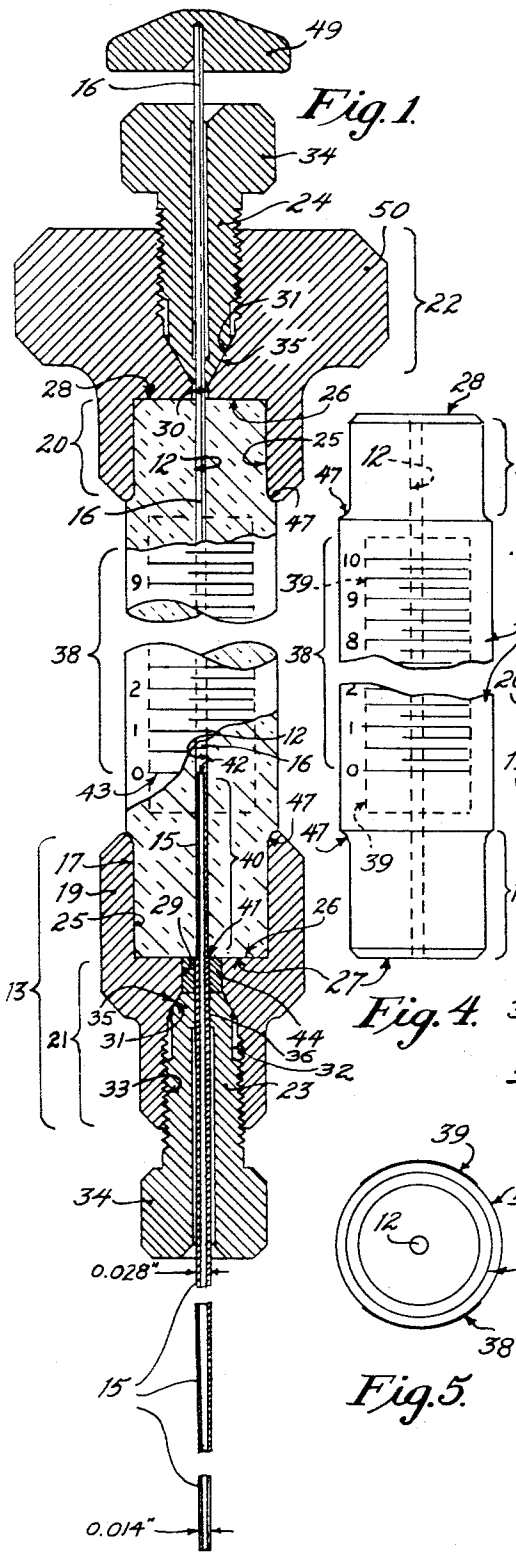
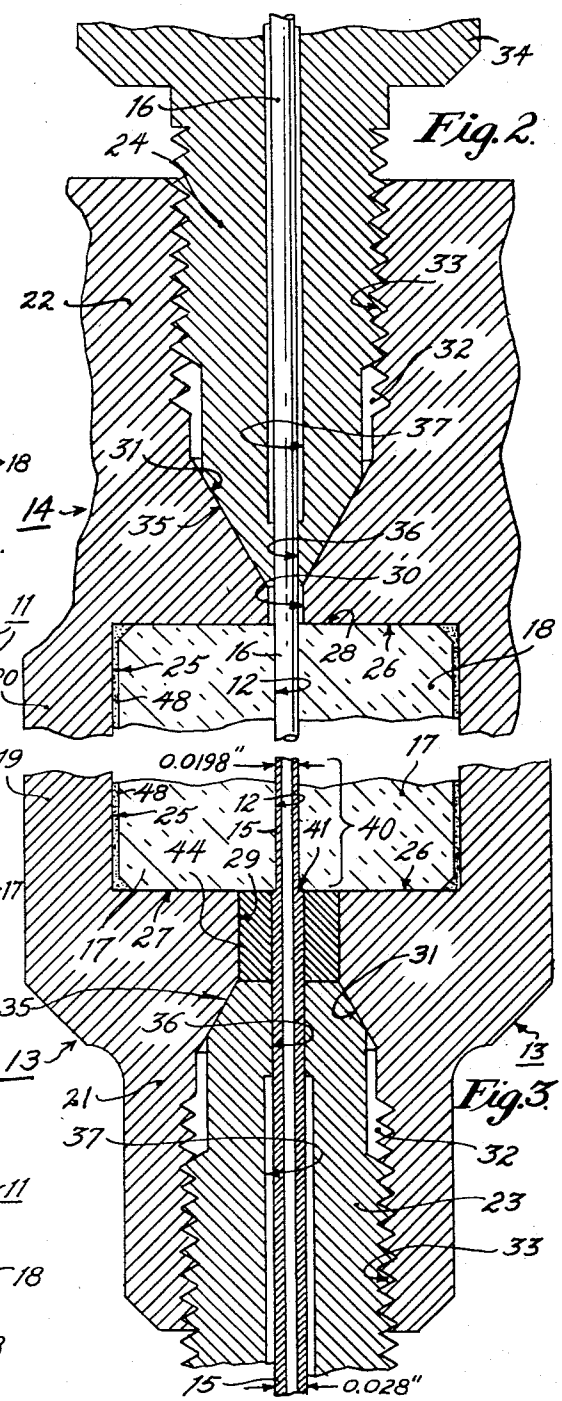
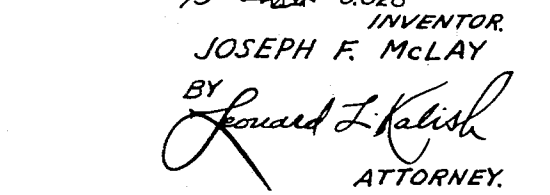
Dec. 24, 1968 J. F. McLAY 3,417,904

SYRINGE AND METHOD OF MAKING SAME

Filed Jan. 11, 1966 2 Sheets-Sheet 1







INVENTOR.
JOSEPH F. McLAY
BY Howard L. Kalish
ATTORNEY.

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Filed Jan. 11, 1966 2 Sheets-Sheet 2

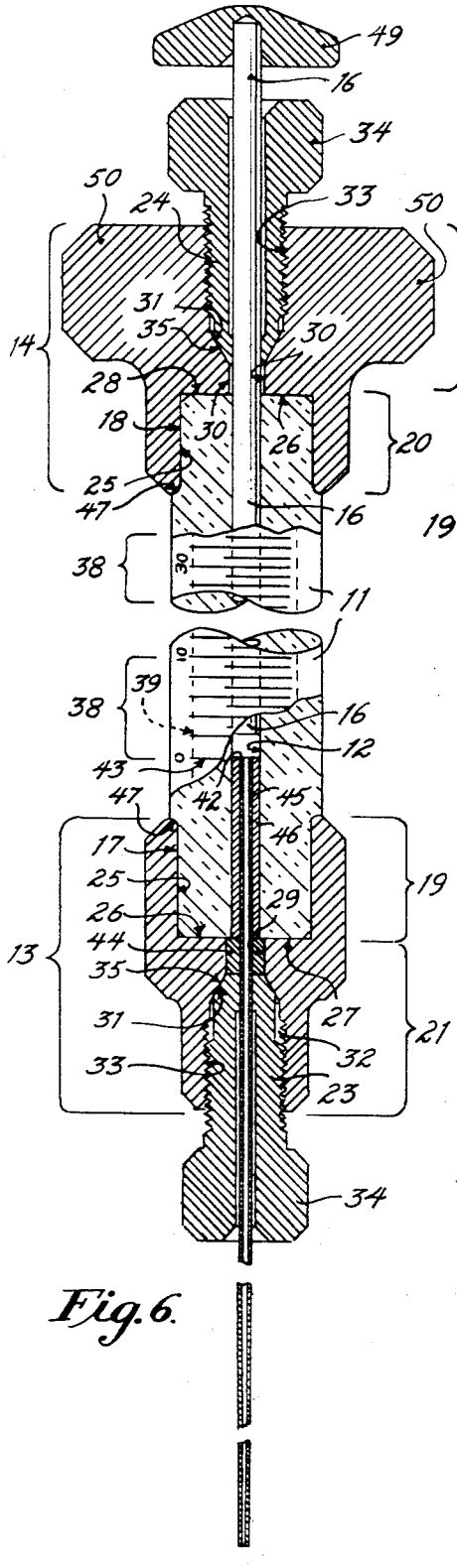


Fig. 6.

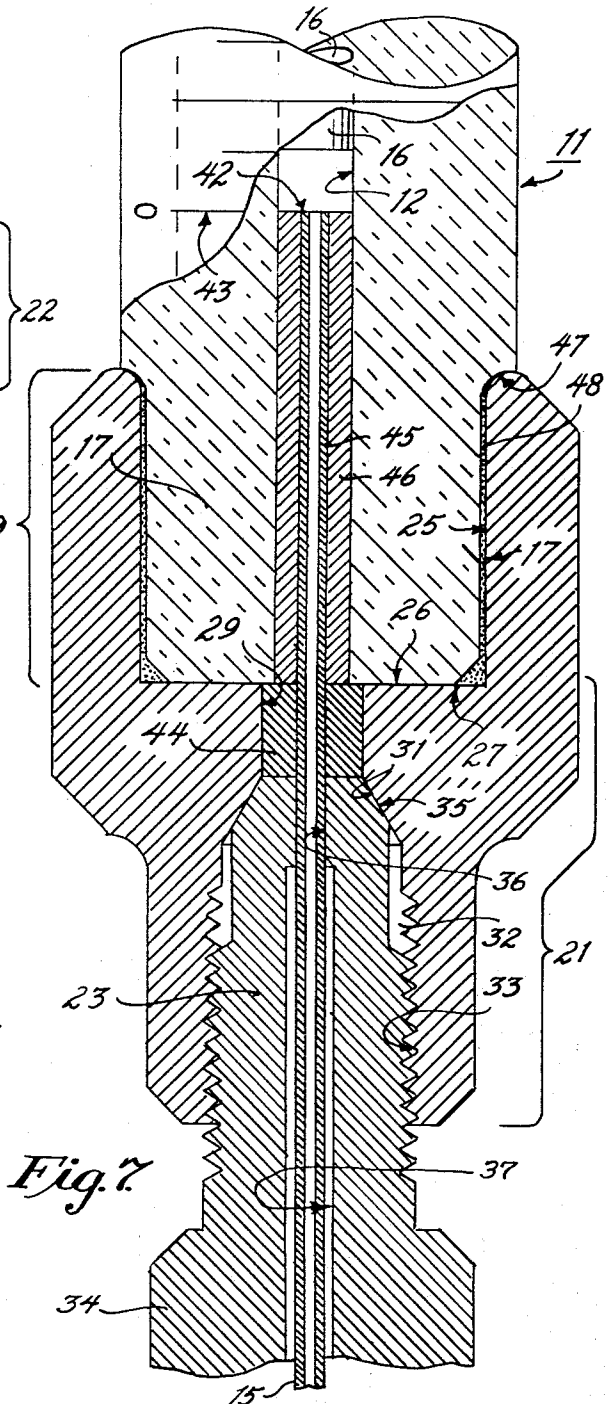


Fig. 7.

INVENTOR.
JOSEPH F. McLAY
BY Leonard I. Kalish
ATTORNEY.

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SYRINGE AND METHOD OF MAKING SAME

Joseph F. McLay, Warminster, Pa., assignor to Fischer & Porter Company, Warminster, Pa., a corporation of Pennsylvania

Filed Jan. 11, 1966, Ser. No. 519,874
33 Claims. (Cl. 222—386)

ABSTRACT OF THE DISCLOSURE

A micro-syringe with a thick-walled glass barrel having unglazed outer terminal portions and a glazed outer portion intermediate the unglazed terminal portions and a plunger-mounting gland-body and a needle mounting gland-body formed of Teflon or the like, each having a thick-walled cup-like barrel-receiving portion telescoped over the respective unglazed terminal portions of the glass barrel and fixedly bonded thereto without external clamping means, and a tubular gland-operator screw-threaded to each gland-body, and a radially compressible tubular sleeve formed of Teflon or the like and having an outer wedging surface disposed in each gland-body and arranged to be radially compressed by tightening the screw-threads between the gland-body and the gland-operator.

The specification

The present invention relates to a certain new and useful micro-syringe construction and method of making same whereby the hypodermic needle and the plunger may be more effectively mounted to the opposite ends of the glass barrel or body of the syringe, and whereby a more effective micro-syringe is provided.

In the accompanying drawings, like reference-characters indicate like parts.

FIGURE 1 represents an enlarged partly sectioned elevational view of a micro-syringe, representing an embodiment of the present invention, on a scale of about three to three-and-three quarter times actual size.

FIGURES 2 and 3 represent still greater enlargements of cross-sectional views, respectively, of the plunger-mounting and needle-mounting gland-body members and gland-plugs of the embodiment shown in FIGURE 1.

FIGURES 4 and 5 are sectioned elevational and top plan views, respectively, of the glass body or barrel of the illustrated embodiments of the micro-syringe of the present invention.

FIGURE 6 represents a partly sectioned elevational view of a micro-syringe of another embodiment of the present invention, on the same scale as FIGURE 1.

FIGURE 7 represents a sectioned elevational view (on the same enlarged scale as FIGURES 2 and 3) of the needle-mounting gland-body member and gland-plug (and the corresponding end of the glass barrel) of the embodiment shown in FIGURE 6.

The body or barrel **11** of the micro-syringe is in the form of a thick-walled glass tube, preferably of a high melting-point boro-silicate glass, having a precision-bore **12** therethrough, accurately sized to the selected diameter and having a glazed cylindrical bore of uniform diameter throughout its length.

Similar gland-body members **13** and **14** of "Teflon" or the like are provided at the needle-end and at the plunger-end, respectively, of the thick-walled glass syringe-body **11**, through which the gland-body members polished steel tubular needle **15** and the polished steel plunger-rod **16** extend and in which they are operatively mounted.

The opposite terminal portions **17** and **18** of the glass body **11** are ground down to a diameter somewhat less than the original outer diameter of the glass body **11**, so as to make these outer cylindrical terminal portions **17** and **18** accurately co-axial with the bore **12** of the syringe body **11**, and so as also to roughen or de-glaze these outer terminal portions **17** and **18** for forming a secure bond with the film **48** of epoxy-resin or thermo-plastic resin or thermo-setting resin bonding material interposed between these glass terminal surfaces **17** and **18** and the aforementioned "Teflon" gland-body members **13** and **14** telescoped thereover in a manner hereinafter described. The terminal portions **17** and **18** of the glass barrel **11** may also be de-glazed by sand blasting or by etching with hydrofluoric acid.

Each of the "Teflon" gland-body members or syringe-caps **13** and **14** includes a generally tubular or sleeve-like glass-encasing portion **19** and **20** in the form of a thick-walled hollow cylinder which is telescoped onto the corresponding ground or de-glazed terminal portion **17** and **18** of the glass body or barrel **11**, and plug-receiving or head portions **21** and **22** in or to which the gland-plugs or gland-operators **23** and **24**, formed of "Teflon" or the like, are screw-threadedly mounted. The radial thickness of the wall of the barrel-receiving portion **19** and **20** is of the order of 25 to 50% or more of the radius of the barrel-receiving chamber **25** therein, so that when it is telescopically pressed onto the terminal portion **19** and **20** of the glass barrel, with an interference fit, at ambient temperature, or is heat-shrunk thereonto in the manner hereinafter described, the cross-section of said wall (in a plane in which its axis lies) will be great enough self-supportingly to exert a sufficient compressive force on the terminal portion **17** and **18** of the glass barrel and on the intervening film of bonding plastic securely to fixate the gland-body member **13** and **14** on the glass barrel without such wall (of the chamber **25**) in time losing its contractive force without the aid of a compressively encasing metallic shell surrounding the sleeve-like "Teflon" portion **19** and **20** of the gland-body member **13** and **14**.

The inner diameter of the barrel-receiving chambers **25** of the gland-body members or syringe-caps **13** and **14** may be made equal to 0.001" less than (or otherwise so diametered in relation to) the outer diameter of the unglazed terminal glass portion **17** and **18** of the glass barrel **11**, so as to provide an interference fit between such two surfaces when telescoped to each other at ambient temperature, or the inner diameter of the chambers **25** may be made less than the outer diameter of the corresponding glass terminal portion **17** and **18** of the glass barrel **11** by about 0.008" to 0.012", for the heat-shrinking of the chamber **25** onto the glass terminal portion **17** and **18**. The sleeve-like portions **19** and **20** of the gland-body members **13** and **14** (containing the barrel-receiving chambers **25**) either forcibly telescoped onto the de-glazed terminal portions **17** and **18** of the glass barrel and

so resiliently expanded while at ambient temperature or are telescopetd over the glass terminal portions **17** and **18** while the gland-body members are maintained at a temperature of the order of 500° F., at which temperature the cylindrical bores or barrel-receiving chambers **25** thereof are expanded to a diameter substantially greater than that of the glass terminal portion **17** and **18**; in the manner or by the method more fully described hereinafter.

The shoulder **26** in each of the barrel-receiving chambetrs **25** is disposed transversely of and preferably normal to the axis of the gland-body member **13** and **14** and bear against the opposite ends **27** and **28**, respectively, of the glass syringe-body of barrel **11**.

Short passageways **29** and **30** respectively, are provided in the gland-members **31** and **14**, co-axial with the barrel-receiving bores **25** thereof. The needle **15** and the plunger **16** extend through the passageways **29** and **30**, respectively. The cylindrical passageway **30** in the plunger-mounting gland-member **14** is slightly larger (by about 0.002") than the outer diameter of the plunger **16**. The outer diameter of the plunger **16** is just sufficiently smaller than the inner diameter of the bore **12** of the barrel **11** to make a close sliding fit therewith with minimum clearance and without any (or but slight) friction. The cylindrical passageway **29** in the needle-mounting gland-member **13** is substantially larger than the outer diameter of the needle **15** as indicated in FIGURES 1, 3, 6 and 7.

The outer ends of the passageways **29** and **30** terminate at the inner small ends of the co-axial conical wedging-chambers **31**, whose concave conical walls **31** are at about a 30° angle to the axis thereof. Outwardly of the wedging chamber **31**, a co-axial plug-mounting chamber **32** is provided in each of the gland-bodies **13** and **14**, having screw-threaded portions **33**, in which the correspondingly screw-threaded gland-plugs **23** and **24**, respectively, are operatively mounted. Each of the gland-plugs **23** and **24** has a knurled head-portion **34** at its outer end and a tapered or conical wedging-portion **35** at its inner end.

Each of the gland-plugs **23** and **24** is provided with a stepped bore, co-axial wtih the threaded portion thereof, including a smaller-diametered sealing-portion **36** within the wedging-portion **35**, and a larger-diametered clearance-bore-portion **37** extending from the outer end thereof to the sealing-portion bore-portion **36** thereof. The needle-mounting sealing-bore portion **36** of the gland-plug **23** is of an initial diameter slightly (0.001" to 0.003") smaller than the outer diameter of the needle **15**, while the plunger-mounting sealing-bore **36** of the gland-plug **24** is preferably of the same initial diameter as the outer diameter of the plunger **16** mounted therein. When the needle **15** is telescoped into the smaller diametered sealing-bore portions **36** of the gland-plug **23** it resiliently expands said bore correspondingly. In either case however, by tightening the plugs **23** and **24** in the gland-bodies **13** or **14**, the convex conical wedging surfaces **35** of the plugs **23** and **24** are wedged against the concave conical surface **31** in the gland-bodies **13** and **14** and thereby compress the sealing-bore-portions **36** and tighten the same against the outer cylindrical surfaces of the needle **15** and plunger **16** respectively; thereby adjustably to increase the fluid-seal and frictional resistance between such bore portions **36** of the gland-plugs **23** and **24** and the needle **15** and the plunger **16**, respectively, and thereby also to form a fluid-seal between the juxtaposed concave conical surfaces **31** of the gland-body members **13** and **14** and the convex conical surfaces **35** of the gland-plugs **23** and **24**.

On the outer cylindrical surface of the glass barrel **11** of the syringe an appropriate scale **38** is provided, graduated in micro-liters (or in any other suitable graduation) formed of a suitably colored lower-melting glass fused to the barrel **11**; the scale **38** being formed by applying to the barrel a vitreous or ceramic decalcomania of a heat-destructible sheet with the scale carried thereon of a lower-melting colored glass facing the barrel; such scale being fused to the outer wall of the barrel by heating it to a suitable temperature. A thin-opaque white (or other suitably reflective opaque) layer **39** of a lower-melting glass is similarly fused to the diametrically opposite portion of the outer surface of the barrel **11** as indicated in FIGURES 4 and 5.

In the embodiment shown in FIGURES 1, 2 and 3, the outer diameter of the needle **15** is slightly greater than the diameter of the bore **12** of the glass barrel **11**, and the portion **40** of the needle **15**, which is telescoped into the bore **12** of the glass barrel **11**, is reduced to a diameter snugly to fit within the bore **12**; thereby also providing a shoulder **41** between the reduced-diametered portion **40** of the needle **15** and the main body thereof. The shoulder **41** bears against the end **27** of the glass barrel **11**, and thus fixes the position of the inner end **42** of the needle **15** so as to place it in registration with the zero-line **43** of the scale **38**.

In order to prevent any axial displacement of the needle **15** in either direction, as for instance, to prevent the needle **15** from being pushed outwardly of the glass barrel **11** by the plunger **16**, when the plunger is pushed fully into the barrel **11** and into abutment with the inner end **42** of the needle or to prevent the inward displacement of the needle **15** when its outer end is operatively applied, a metallic sleeve, thrust-collar or ferrule or needle-positioner **44** is telescopically mounted on the needle **15** and soldered or otherwise permanently affixed thereto. The inner end of the thrust-collar or ferrule **44** bears or abuts directly against the end **27** of the glass barrel **11**. The axial length of the collar **44** is such that the innermost end of the gland-plug **23** bears against the outer end of the collar **44** when the gland-plug **23** is tightened into place with its convex conical wedging portion **35** operatively wedged into the concave conical wedging chamber **31** of the gland-body **13**.

When the bore **12** of the glass barrel **11** is larger than the outer diameter of the needle **15**, so that there would be annular clearance or gap between the bore **12** and the telescoped portion **45** of the needle **15**, as indicated in FIGURES 6 and 7, a gap-filling sleeve or adapter **46** of "Teflon" (or the like) is interposed between the bore **12** and the telescoped portion **45** of the needle **15**, as shown in FIGURES 6 and 7. The gap- filling sleeve **46** is so dimensioned that it fits snugly over the telescoped portion **45** of the needle **15** and so that it also fits snugly into the bore **12** of the glass barrel **11**.

By the construction according to the present invention, the forces generated by the operative tightening of the gland-plugs **23** and **24** in their corresponding gland-bodies **13** and **14** are distributed almost entirely to the "Teflon" gland-body itself, without any significant tendency to separate the gland-body from the glass barrel **11**. All the forces generated by tightening the plunger-sealing gland-plug **24** in the gland-body **14** are distributed to the gland-body itself. The same is true of the forces generated when the gland-plug **23** is tightened into the gland-body **13**, except for a very slight axial force between the innermost end of the gland-plug **23** and the outer end of the thrust-collar **44**. However, this force is very slight because the cross-sectional area of the contact between the thrust-collar and the innermost end of the conical portion **35** of the gland-plug **23** is very small and the resiliency of the "Teflon" (or other plastic material) of which the gland-plug **23** is formed tends to minimize such axial force.

A thumb-knob or head **49** is affixed to the outer end of the steel plunger **15** and the plunger-mounting gland-body member **14** is provided with an enlarged flange **50** for engagement by the fore-finger and the adjacent finger.

The gland-plugs **23** and **24** and the gland-body members **13** and **14** are formed of "Teflon" or another solvent-resistant and chemically inert form-retaining synthetic

resin or "plastic" having a coefficient of thermal expansion several or many times greater than that of the glass-barrel **11** and which (resin) is slightly resiliently-deformable or yieldable and has a capacity for recovering from small deformations thereof after the deforming force is removed, and which will not seize or "freeze" to a glazed glass surface or to a polished steel surface when pressed thereagainst for a long time in a dry or unlubricated condition but will slide therealong in a self-lubricating relationship therewith and form a good stationary as well as sliding fluid-sealing contact therewith when pressed against such a glazed or polished surface and which will withstand relative high temperatures (at least about 300° F. and preferably 500° F.) without melting or softening and without chemical or physical deterioration and which is generally non-wetting in relationship to liquids. The preferred synthetic-resins (or plastics) are the polymerized fluoro-carbons exemplified by the polymerized polytetrahaloethylene or polymerized polytetrafluoroethylene resins described in U.S. Patent 2,230,654 (Roy J. Plunkett) issued Feb. 4, 1941, and marketed under the trademark "Teflon" and the polymerized polytrifluorochloroethylene resins marketed under the trademark "Kel–F," and also fluorinated ethylene-propylene resins marketed under the trademark or trade-designation "F.E.P. Teflon" and "Teflon 100."

These synthetic resins are also preferred for the glass-encasing gland-body members **13** and **14** because of their high coefficient of thermal expansion permitting the heat-shrinking of the barrel-receiving portions **19** and **20** of the gland-bodies **13** and **14** onto the terminal portions **17** and **18** of the barrel **11** as described more fully hereinafter.

Examples of other though perhaps less preferred synthetic resins are the polypropylene resins exemplified by the commercially available product marketed under the trademark "Profax," the polyethylene resins exemplified by the commercially available product marketed under the trademark "Marlex," the nylon resins exemplified by the commercially available product marketed under the trademark "Plaskon," the polyvinylchloride resins exemplified by the commercially available product marketed under the trademark "Ultron," and the polystyrene resins exemplified by the commercially available product marketed under the trademark "Styron."

Prior to the telescopic assembly of the gland-body members **13** and **14** and the respective glass terminal portions **17** and **18**, the barrel-receiving bores or chambers **25** of the resin members **13** and **14** are treated with a composition of anhydrous ammonia and an alkali metal such as sodium. This treatment generally takes approximately a minute or so, namely, until a thin or very slight adherent carbon layer is formed on the bore surfaces **25** of these resin members; such carbon layers being recognizable by the bore surfaces **25** gradually turning from their initially generally white or egg-shell color to a brown color of increasing degree of darkness as the treatment is continued.

In the embodiment in which the barrel-receiving portions **19** and **20** of the gland-body members **13** and **14** are cold-pressed onto the de-glazed cylindrical surfaces **17** and **18** of the glass barrel or such terminal glass portions **17** and **18** are forcibly telescoped into the chambers **25** while at ambient temperature, an epoxy resin or other cold-setting soft or flowable synthetic resin plastic bonding material is first applied either to the so treated cylindrical inner surfaces of the chambers **25** or to the unglazed outer cylindrical surfaces **17** and **18** of the glass barrel, and thereafter the two members are forcibly telescoped in relation to each other. In such forcible telescoping, the cylindrical walls in **19** and **20** are resiliently stretched to a slight extent and thereby develop a permanent contractive force exerting a radially inward pressure against the unglazed glass surfaces to the bonding material therebetween. However, if a thermo-plastic synthetic-resin bonding material is used in this embodiment, such resin may be applied to the unglazed terminal glass portions **17** and **18** while either the resin or the glass is at a temperature at which such resin melts or is adequately plasticized or fluidized, and thereafter the barrel-receiving portions **19** and **20** and gland-body members **13** and **14** are forcibly telescoped onto the terminal glass portions **17** and **18**; without first heating the barrel-receiving portions **19** and **20** of the gland-body members **13** and **14**. The coefficient of thermal expansion of the bore-silicate glass is so slight as to be negligible in this relation.

In the heat-shrinking embodiment, the epoxy resin is applied to the unglazed glass surfaces **17** and **18**, and the gland-body members **13** and **14** (or at least the barrel-receiving portions **19** and **20** thereof), with the inner cylindrical surfaces of the chambers **25** thereof treated in the aforementioned manner, are heated to a temperature of approximately 500° F., thereby to cause the diameters of the bores or chambers **25** thereof materially to expand or enlarge to an extent providing several thousandths of an inch clearance between the initially smaller cold-diameters of the bores **25** and the outer ground cylindrical surfaces **17** and **18** of the glass barrel **11** to be telescoped into the chambers **25**. Thus, for example, with the outer diameters of the terminal portions **17** and **18** of the glass barrel .275" and with the resin gland-body members **13** and **14** formed of "Teflon," the bores or chambers **25** of such resin members **13** and **14** may be provided with an original (cold) inner diameter of approximately .265" to .270", which is thereafter expanded by about .011" or .012" by such heating, thereby making the heated diameter of the chamber **25** about .276–.277" to .281–.282," and hence providing a diametral clearance of about .001–.002" to .006–.007" for the telescopic assembly of the resin members **13** and **14** and glass ends **17** and **18** with an epoxy or bonding resin coating or film on the outer cylindrical surfaces of the glass ends **17** and **18** or on the inner surfaces of the chambers **25**. These dimensions are illustrative, and represent relative dimensions or proportions which may be applied to sizes different from that illustrated in the drawings. The clearances between the glass terminal portions **17** and **18** and the inner walls of the chambers **25** when the portions **19** and **20** are heated should however be of the order of the clearance above indicated.

Either prior to or during the heating of the resin members **13** and **14**, the outer ground surfaces **17** and **18** of the ends of the glass barrel **11** (which will ultimately be disposed within the chambers **25** of the resin members) are coated with an admixture of an adhesive or bonding epoxy resin and a catalyst or accelerator therefor. Such coating or film may be sufficiently thick so that some of said bonding resin will be scraped off toward the shoulders **47** at the inner ends of the glass terminal portions **17** and **18**, as such glass terminal portions **17** and **18** and the sleeve-like portions **19** and **20** of resin gland-body members **13** and **14** are later telescoped in relation to each other.

While the resin members **13** and **14** are at the aforementioned temperature, with their bores or chambers **25** expanded or enlarged, the so epoxy-coated glass terminal portions **17** and **18** are telescoped thereinto, to form the structure indicated in FIGURES 1, 2, 3, 6 and 7 of the drawings.

The excess epoxy resin or bonding material which is scraped toward the inner ends or shoulders **47** of the terminal glass portions **17** and **18** and thus gathered around the glass barrel just beyond the shoulders **47**, may be thereafter mechanically removed.

After cooling (and the removal of any excess epoxy resin which may be extruded exteriorly of the glass barrel **11**) the assembly of the resin gland-body members **13** and **14** and glass barrel **11** is permitted to cure, namely, is given sufficient time for the epoxy resin firmly to set and harden.

By reason of the initially oversize diameter of the outer cylindrical glass surfaces **17** and **18** in relation to the barrel-receiving chambers **25** and the subsequent shrink-fitting of the bores or chambers **25** onto said oversized glass surfaces **17** and **18**, only a very thin layer of the epoxy remains between the shrinkfitted contiguous cylindrical resin and glass surfaces; such epoxy layer being so thin that it cannot be shown to scale in the drawings, and is hence indicated as a disproportionately thick layer **48** in FIGURES 2, 3 and 7.

Instead of interposing an epoxy-resin bonding-layer between terminal glass surfaces **17** and **18** and the barrel-receiving bores or chambers **25**, a thin layer (.002" to .010") of a high-melting-point thermo-plastic halogenated - hydrocarbon synthetic - resin may be used; whose melting-point is 50° F. to 100° F. below the temperature to which the gland-body members **13** and **14** are heated to enlarge the chambers **25** thereof to an inner diameter substantially greater than the outer diameter of the glass terminal surfaces **17** and **18**. Thus, after the inner surfaces of the barrel-receiving chambers **25** have been treated with a solution of anhydrous ammonia and an alkali metal (such as sodium) in the manner hereinabove described, a thin ribbon-like or band-like layer or skiving of a chlorinated ethyl propylene or of a fluorinated ethylene propylene, having a melting point of the order of 450° F., is applied to the inner cylindrical surfaces of the barrel-receiving chambers **25**, so as to overlap or cover said surfaces in a complete circle; such layer or skiving being of the thickness of the order of .002" to .005" or gap obtained between the glass surface **17** and **18** and the cylindrical inner surface of the chamber **25** when the latter is at a temperature of about 500° F. to 550° F. Thereafter the gland-body members or at least the chamber-containing portions **19** and **20** thereof, are heated to a temperature of about 500° F. to 550° F., at which temperature the aforementioned thermo-plastic resin melts or sufficiently softens while the material of the gland-body members is unaffected either chemically or physically (except for the linear expansion or enlargement thereof in accordance with its high coefficient of thermal expansion), and at which temperature the barrel-receiving chambers **25** of the gland-body members are expanded so that their inner diameters are greater than the outer diameters of the terminal glass surfaces **17** and **18** by an amount approximately equal to or slightly in excess of twice the thickness of the aforementioned ribbon-like or band-like skiving or layer of thermo-plastic halogenated hydrocarbon. Thereafter the respective glass terminals **17** and **18** are telescoped into the chambers **25** of the so heated inner portions **19** and **20** of the gland-body members; in which chambers the aforementioned thermoplastic synthetic-resin bonding material has melted or sufficiently softened to form a thick viscous coating on the inner cylindrical surface of the chamber **25**. In so telescoping the terminal portion **17** or **18** of the glass barrel **11** into the heated and molten plastic-coated chamber **25**, some of the molten plastic may be scraped off inwardly of the chamber and disposed between the end **27** or **28** of the glass barrel **11** and a transverse shoulder **26** of the barrel-receiving chamber **25**, thereby to form a bond between such surfaces.

Upon the cooling of the so telescoped assemblage to ambient temperature, the thermo-plastic halogenated hydrocarbon forms a firm bond between the inner surface of the chamber **25** (treated in the aforementioned manner) and the roughened terminal surface **17** or **18** of the glass barrel **11**, which (bond) together with the shrinking of the thick annular wall of the inner portion **19** or **20** of the gland-body member **13** and **14** onto the glass terminal portion **17** or **18**, fixates such gland-body members **13** and **14** on the glass barrel.

Either by the aforementioned cold forcible telescoping of the so treated chamber **25** onto the de-glazed terminal glass portion **17** and **18** with the bonding resin therebetween, or by the aforementioned heat-shrinking of such chamber **25** onto such unglazed terminal glass portions, with an epoxy or other synthetic bonding resin therebetween, the resultant fixation of the gland-body member **13** and **14** on the glass barrel also provides a secure fluid-seal and gas-seal between such telescoped cylindrical surfaces which will withstand any fluid or gas pressure which may be generated within the bore of the barrel when the plunger **16** is advanced. The firm abutment of the flat ends **27** and **28** of the glass barrel against the flat inner end-walls **26** of the barrel-receiving chambers **25** also serves to prevent fluid from entering between such surfaces. Such fluid-exclusion may be augmented by the interposition of a slight film of the bonding resin between the flat glass surfaces **27** and **28** and the flat resin surfaces **26**.

In the following Table A is a tabulation of typical dimensions and proportions of five different sizes or capacities of the micro-syringes (and of their parts and elements) illustrated in the drawings and made by the foregoing method. The dimensions given in the following tabulation are of the median dimensions, which may vary by appropriate tolerances of a few ten-thousandths of an inch. These tolerances are omitted in the following tabulation for the sake of simplicity or illustration.

TABLE A

	Capacity of syringe in microliters (or in cubic millimeters)				
	10	25	50	100	500
(A) Outer diameter of the barrel 11 (in.)	.300	.300	.300	.300	.340
(B) Inner diameter of the bore 12 of the glass barrel 11 (in.)	.0204	.0314	.0456	.0600	.1425
(C) Length of the barrel 11 (in.)	3¼	3¼	3¼	3¼	3¼
(D) Diameter of plunger 16 (in.)	.0202	.03115	.04525	.0596	.1421
(E) Outer diameter of the main body of the needle 15 (in.)	.028	.028	.028	.028	.028
(F) Outer diameter of the glass-telescoped portion 45 of needle 15 (in.)	.0198	.028	.028	.028	.028
(G) Outer diameter of the reduced tip portion of the needle 15 (in.)	.014	.014	.014	.014	.014
(H) Bore of the needle 15 (in.)	.006	.006	.006	.006	.006
(I) Diameter of de-glazed surfaces 17 and 18 (in.)	.275	.275	.275	.275	.305
(J) Initial (cold) inner diameter of barrel-receiving chamber 25 in gland-body members (13 and 14) (in.)	.265	.265	.265	.265	.295
(K) Inner diameter of the barrel-receiving chamber 25 of "Teflon" gland-body members (13 and 14) when heated to 550° F. (in.)	.276	.276	.276	.276	.307
(L) Initial (cold) outer diameter of sleeve-like portions 19 and 20 (in.)	(13/32) .4067	(13/32) .4067	(13/32) .4067	(13/32) .4067	(7/16) .4375
(M) Wall-thickness of sleeve-like portions 19 and 20 (in.)	.0708	.0708	.0708	.0708	.0712
(N) Ratio of wall-thickness M to radius of chamber 25 (when cold), percent	51.5	51.5	51.5	51.5	48.2

The gland-body members **13** and **14** may also be applied to the reduced-diameters de-glazed terminal portions **17** and **18** of the glass barrel **11** without heat-shrinking, but with the interposition of a film of an epoxy resin or a heat-setting synthetic-resin or a thermo-plastic synthetic-resin or other suitable binding material compatible with the inner surface of the barrel-receiving chamber **25** after it has been treated with the admixture of anhydrous ammonia and alkali-metal in the manner pointed out hereinabove. Thus, because the material of which the gland-body members **13** and **14** are formed is slightly resiliently deformable, the sleeve-like portions **19** and **20** thereof may be affixed to the de-glazed terminal portions **17** and **18** of the glass barrel **11** by making the initial inner diameter of the barrel-receiving chamber **25** the same as or a thousandth of an inch or so larger than the outer diameter of the de-glazed terminal surface **17** and **18** of the glass barrel **11**, and then applying a suitably thick epoxy-resin (of a paste-like consistency) to such de-glazed surface **17** and **18** and telescoping the sleeve-like portion **19** and **20** of the gland-body member **13** and **14** over such de-glazed surface **17** and **18** at ambient temperature, and then removing the excess epoxy-resin which may be scraped towards the shoulders **47** of the barrel **11** and which may surround the barrel beyond such shoulders; and thereafter permitting the epoxy-resin to set or harden.

The following is claimed:

1. A syringe including

(A) a thick-walled glass barrel having

(A1) a glazed outer surface and

(A2) a glazed bore and

(A3) a terminal portion with an unglazed outer surface,

(B) a gland-body member operatively mounted on said unglazed terminal portion of the glass barrel,

(B1) said gland-body member being formed of a chemically inert and solvent-resistant and generally form-retaining synthetic resin which is slightly resiliently deformable by cold-flow,

(B2) said gland-body member including a generally cylindrical thick-walled cup-like barrel-attached portion whose interior constitutes a barrel-receiving chamber into which said unglazed terminal portion of the glass barrel is telescoped with substantial interference-fit,

(B3) the wall of said barrel-receiving chamber being sufficiently thick in relation to said interference-fit that such wall-thickness and interference-fit, together, fixedly secure the glass barrel and the gland-body member to each other in fluid-tight relation without the barrel-attached portion of the gland-body member being clamped to the telescoped terminal portion of the glass barrel by any external clamping means, and

(B4) said gland-body member having an outer screw-threaded gland-operator-receiving portion,

(B5) a passageway between said barrel-receiving chamber and said gland-operator-receiving portion,

(C) a tubular gland-operator screw-threadedly mounted to said gland-operator-receiving portion of the gland-body-member and screw-adjustable in respect thereto,

(D) a rod-like metallic syringe element extending through said gland-operator and said gland-body member and into the bore of said glass barrel and having an outer portion thereof disposed externally of said gland-operator,

(E) said gland-operator and said gland-body member having operatively juxtaposed complementary wedging portions arranged to be pressed against each other the screw-tightening of gland-operator in relation to the gland-body member and radially to compress one of said wedging portions into fluid-sealing engagement with said rod-like element.

2. A syringe including

(A) a glass barrel having

(A1) a glazed outer surface and

(A2) a glazed bore and

(A3) a terminal portion with an unglazed outer surface,

(B) a gland-body member operatively mounted on said unglazed terminal portion of the glass barrel,

(B1) said gland-body member being formed of a chemically inert and solvent-resistant and generally form-retaining synthetic resin which is slightly resiliently deformable by cold flow,

(B2) said gland-body member including a thick walled cup-like barrel-attached portion whose interior constitutes a barrel-receiving chamber into which said unglazed terminal portion of the glass barrel is telescoped,

(C) said cup-like portion being heat-shrunk onto said unglazed terminal portion of the glass barrel,

(B3) the wall of said barrel-receiving chamber being sufficiently thick in relation to said heat-shrinkage thereof that such wall-thickness and heat-shrinkage, together, fixedly secure the glass barrel and the gland-body member to each other in fluid-tight relation without the barrel-attached portion of the gland-body member being clamped to the telescoped portion of the glass barrel by any external clamping means,

(B4) and said gland-body member having an outer screw-threaded gland-operator-receiving portion,

(B5) a passageway between said barrel-receiving chamber and said gland-operator-receiving portion,

(D) a tubular gland-operator screw-threadedly mounted to said gland-operator-receiving portion of the gland-body member and screw-adjustable in respect thereto,

(E) a rod-like metallic syringe element extending through said gland-operator and said gland-body member and into the bore of said glass barrel and having an outer portion thereof disposed externally of said gland-operator, and

(F) said gland-operator and said gland-body member having operatively juxtaposed complementary wedging portions arranged to be pressed against each other by the screw-tightening of gland-operator in relation to the gland-body member and radially to compress one of said wedging portions into fluid-sealing engagement with said rod-like syringe element.

3. A syringe according to claim **2**, including a film of bonding material intervening said unglazed outer surface of the terminal portion of the glass barrel and the juxtaposed inner wall of said barrel-receiving chamber, fixating said gland-body member and said glass barrel in relation to each other.

4. A syringe according to claim **1**, in which the pressure exerted between the two complementary wedging portions when the gland-operator is screw-tightened in relation to the gland-body member is transmitted only to the gland-operator and to the gland-operator-receiving portion of the gland-body member and to the rod-like syringe element extending therethrough.

5. A syringe according to claim **1**, in which the rod-like syringe element is a tubular needle, and including a needle-positioner on said needle of a diameter greater than the diameter of the needle, said needle-positioner being disposed within the gland-operator-receiving portion of the gland-body member and having an inner face abutting against the end of the glass barrel, and the gland operator abutting against an outer face of said needle-positioner.

6. A syringe according to claim 1, having an unglazed outer surface on each of the two terminal portions of the glass barrel and having a gland-body member of the character stated in claim 1 affixed to each of said two unglazed terminal portions of the glass barrel in the manner stated in claim 1, and having a tubular gland-operator of the character stated in claim 1 screw-threadedly mounted to each gland-body member, and having a tubular metallic needle extending through one gland-body member and its gland-operator and into the bore of the glass barrel and having a metallic plunger extending through the other gland-body member and its gland-operator and into the bore of the glass barrel.

7. A syringe according to claim 2, in which the pressure exerted between the two complementary wedging portions when the gland-operator is screw-tightened in relation to the gland-body member is transmitted only to the gland-operator and to the gland-operator-receiving portion of the gland-body member and to the rod-like syringe element extending therethrough.

8. A syringe according to claim 1, in which the tubular gland-operator is formed of chemically inert and solvent-resistant and generally form-retaining synthetic resin which is slightly resiliently deformable by cold-flow.

9. A syringe according to claim 2, in which the gland-operators are formed of a chemically inert and solvent-resistant and generally form-retaining synthetic resin which is slightly resiliently deformable by cold-flow.

10. A syringe according to claim 1, in which the wedging portion of the gland-operator is a convexly shaped inner portion thereof and in which the wedging portion of the gland-body member is a concavely shaped inner portion thereof.

11. A syringe according to claim 9, in which the wedging portions of the gland-operators are inner convexly shaped portions thereof and in which the wedging portions thereof and in which the wedging portions of the gland-body members are concavely shaped inner portions thereof.

12. A syringe according to claim 1 including a film of bonding material intervening the unglazed outer surface of the terminal portion of the glass barrel and the juxtaposed inner wall of the barrel-receiving chamber, compatible with said synthetic plastic and with said unglazed surface.

13. A syringe according to claim 12, in which the barrel-receiving chamber has a thin adherent film of carbon formed in situ on the inner surface thereof and in which the film of bonding material intervenes such carbon film and the unglazed glass surface of the terminal portion of the glass barrel telescoped into said chamber.

14. A syringe according to claim 13, in which the film of bonding material is an epoxy resin.

15. A syringe according to claim 1, in which the unglazed outer surface of the terminal portion of the glass barrel is of a diameter smaller than the outer diameter of the main portion of the glass barrel and in which such unglazed surface is coaxial with the bore of the glass barrel.

16. A syringe according to claim 12, in which the film of bonding material intervening the unglazed outer surface of the terminal portion of the glass barrel and the juxtaposed position of the barrel-receiving-chamber is a thermo-plastic synthetic resin compatible with the inner surface of the barrel-receiving chamber and solid at ambient temperatures.

17. A syringe according to claim 1, in which the film of bonding material intervening the unglazed outer surface of the terminal portion of the glass barrel and the juxtaposed inner wall of the barrel-receiving-chamber is an epoxy resin.

18. A syringe according to claim 3, in which the film of bonding material intervening the enclosed outer surface of the terminal portion of the glass barrel in the juxtaposed inner wall of the barrel-receiving-chamber is a thermo-plastic synthetic resin compatible with the inner surface of the barrel-receiving-chamber.

19. A syringe according to claim 3, in which the film of bonding material intervening the enclosed outer unglazed surface of the terminal portion of the glass barrel patible with the inner wall of the barrel-receiving-chamber is an epoxy resin.

20. A syringe according to claim 13, in which the bonding material is a thermo-plastic synthetic resin compatible with the inner wall of the barrel-receiving-chamber.

21. A micro-syringe including

(A) a thick-walled glass barrel having
  (A1) a small diametered glazed precision bore and
  (A2) a scale on an outer glazed cylindrical surface thereof and
  (A3) unglazed opposite outer cylindrical terminal portions co-axial with the bore thereof and of a diameter less than the diameter of the aforementioned scaled portion thereof,

(B) a gland-body member operatively mounted on each of said unglazed terminal portions of the glass barrel,
  (B1) each of said gland-body members being formed of a solvent-resistant and chemically inert and generally form-retaining synthetic resin which is slightly resiliently deformable and which is capable of forming a non-seizing unlubricated slidable fluid-seal with a glazed glass surface and with a polished metallic surface and which has a coefficient of thermal expansion substantially greater than that of glass,
  (B2) each of said gland-body members including an inner generally cylindrical thick-walled barrel-receiving chamber
    (B2–a) whose initial inner diameter is substantially less than the outer diameter of the corresponding unglazed terminal portion of the glass barrel and
    (B2–b) which is heat-shrunk onto such terminal portion of the barrel,

(C) a thin adherent film of carbon particles formed in situ on the inner cylindrical surfaces of said barrel-receiving chambers and

(D) a film of epoxy resin between said carbon film and the unglazed glass terminal portion therewithin,
  (B3) each o fsaid gland-body members
    (B3–a) having an internally-threaded outer plug-receiving chamber and
    (B3–b) having an inner outwardly-facing concave conical wedging surface and
    (B3–c) having a small-diametered passageway of small axial extent intermediate the barrel-receiving chamber and the plug-receiving chamber,

(E) a tubular gland-plug screw-threadedly mounted in each of said plug-receiving chambers,
  (E1) said gland-plugs being formed of a solvent-resistant and chemically inert and generally form-retaining synthetic resin which is slightly resiliently deformable and which is capable of forming a non-seizing unlubricated slidable fluid-seal with a glazed glass surface and with a polished metallic surface and,
  (E2) each of said gland-plugs having an inner convex conical portion juxtaposed to and arranged to coact with the aforementioned concave conical wedging surface of the plug-receiving chamber to compress such convex conical portion of the gland-plug, and
  (E3) each of said gland-plugs having an axial bore portion in operative juxtaposition to the convex conical portion of the gland-plug and of a diameter forming an interference fit with the

outer cylindrical surface of the below-mentioned needle and plunger respectively,

(F) a tubular needle having an outer portion thereof extending through one of said gland-plugs and forming an interference fit with the bore portion thereof which is in operative juxtaposition to convex conical portion thereof and extending through said small-diametered passageway in the corresponding gland-body member and having the innermost portion thereof telescoped into the bore of the glass barrel

(G) a needle-positioner fixedly associated with said needle and disposed within said small-diametered passageway in the gland-body member,

(G1) said needle-positioner having an inner surface thereof abutting the end of the glass barrel and having an outer surface thereof abutting the innermost end of said gland-plug when the latter is operatively tightened into its gland-body member,

(H) a plunger extending through the other gland-plug and forming an interference fit with the bore portion thereof which is in operative juxtaposition to convex conical portion thereof and extending through the small-diametered passageway in the corresponding gland-body member and variably telescoped into the bore of the glass barrel, and

(I) a handle on the outer end of said plunger.

22. In the manufacture of syringes with glass barrels, the method of making a gland-body member therefor and affixing it to the end of the glass barrel, which includes

(A) forming a gland-body member

(A1) of a substantially chemically inert and solvent-resistant and generally form-retaining synthetic resin which is slightly resiliently deformable and which remains solid and chemically stable at a temperature of the order of 500° F. and which is capable of forming a non-seizing dry-slidable fluid-seal with a hard polished complementary surface,

(A2) with a sleeve-like portion at one end thereof having a barrel-receiving chamber therein and with a gland-operator-receiving portion at the other end thereof,

(A3) with the inner diameter of the barrel-receiving-chamber thereof such as to form an interference fit with the outer diameter of the below-mentioned deglazed portion of the barrel, and

(A4) with the wall thickness of said sleeve-like barrel-receiving portion of the gland-body member (in relation to its diameter) such that when the below mentioned de-glazed portion of the barrel is telescoped thereinto with a layer of bonding plastic therebetween, a cross-sectional area of such wall in a plane its axis lies will self-supportingly compressively embrace the telescoped portion of the barrel without in time losing its compressive force without the end of an encasing metallic shell compressively embracing the sleeve-like portion,

(B) de-glazing the terminal portion of the exterior surface of the glass barrel to be telescoped into the sleeve-like portion of the gland-body member,

(C) applying to one of the two surfaces to be telescoped a coating of a bonding plastic compatible with the inner telescoped surface of the gland-body member, and

(D) telescoping the de-glazed portion of the glass barrel into the sleeve-like portion of the gland-body member with substantial interference fit therewith.

23. In the manufacture of syringes with glass barrels, the method of making a gland-body member therefore and affixing it to the end of the glass barrel, which includes

(A) forming a gland-body member

(A1) of a substantially chemically inert and solvent-resistant and generally form-retaining synthetic resin which is slightly resiliently deformable and which remains solid and chemically stable at a temperature of the order of 500° F. and which is capable of forming a non-seizing dry-slidable fluid-seal with a hard polished complementary surface and which has a coefficient of thermal expansion substantially greater than that of the glass barrel,

(A2) with a sleeve-like portion at one end thereof having a barrel-receiving chamber therein and with a gland-operator-receiving portion at the other end thereof,

(A3) with the inner diameter of the barrel-receiving chamber thereof less than the corresponding outer diameter of the below-mentioned de-glazed portion of the glass barrel by an amount slightly less than the below-stated thermal expansion of the barrel-receiving portion, and

(A4) with the wall thickness of the sleeve-like barrel-receiving portion of the gland-body member (in relation to its diameter) such that when it is heat-shrunk onto the de-glazed portion of the glass barrel in the below-stated manner the cross-sectional area of the wall thereof in a plane in which its axis lies will self-supportingly exert a sufficient radially inward compressive force on the portion of the glass barrel therein securely to fixate the sleeve-like barrel-receiving portion of the gland-body member on the glass barrel without in time losing its contractive force without the aid of any encasing metallic shell compressively embracing the sleeve-like member,

(B) de-glazing the terminal portion of the exterior surface of said glass barrel which is to be telescoped into said sleeve-like portion of the gland-body member,

(C) heating such sleeve-like portion of the gland-body member to a temperature at which the inner diameter of the barrel-receiving chamber thereof expands to slightly in excess of the outer diameter of the aforementioned de-glazed portion of the glass barrel,

(D) telescoping said de-glazed portion of the glass barrel into said sleeve-like portion of the gland-body member while the latter is at the aforementioned temperature, and

(E) thereafter permitting the so telescoped members to cool off to ambient temperature to shrink the sleeve-like portion of the gland-body member tightly onto said de-glazed portion of the glass barrel.

24. A method according to claim **22**, in which the bonding plastic is a thermo-plastic synthetic resin solid at ambient temperatures.

25. A method according to claim **22**, in which the bonding plastic is an epoxy resin.

26. A method according to claim **22**, including carbonizing the inner barrel-receiving surface of the barrel-receiving chamber to form a thin film of adherent carbon particles thereon prior to the joinder therewith of the bonding plastic.

27. A method according to claim **22**, including subjecting the inner barrel-receiving surface of the barrel-receiving chamber to a composition including anhydrous ammonia and alkali metal prior to the joinder therewith of the bonding plastic.

28. A method according to claim **23**, in which the bonding plastic is a thermo-plastic synthetic resin solid at ambient temperatures.

29. A method according to claim **23**, in which the bonding plastic is an epoxy resin.

30. A method according to claim **23**, including carbonizing the inner barrel-receiving surface of the barrel-receiving chamber to form a thin film of adherent carbon particles thereon prior to the joinder therewith of the bonding plastic.

31. A method according to claim **23**, including subject-

ing the inner barrel receiving surface of the barrel-receiving chamber to a composition including anhydrous ammonia and alkali metal prior to the joinder therewith of the bonding plastic.

32. A method according to claim **31**, in which the bonding plastic is an epoxy resin.

33. A syringe according to claim **1**, in which the radial thickness of the wall of the cup-like barrel-receiving portion of the gland-body member is of the order of 25 to 50% or more of the radius of the barrel-receiving chamber therein.

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STANLEY H. TOLLBERG, *Primary Examiner.*

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