

Jan. 1, 1946.

J. C. SMITH

2,392,104

FABRICATED GLASS ARTICLE AND METHOD

Filed Dec. 10, 1941

3 Sheets-Sheet 1

Fig. 1.

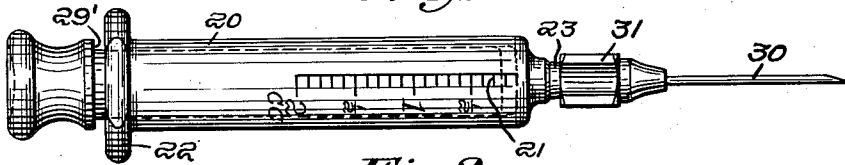


Fig. 2.

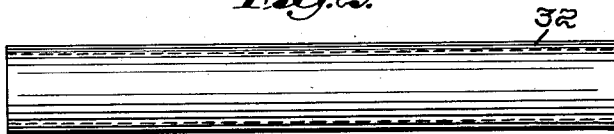


Fig. 3.

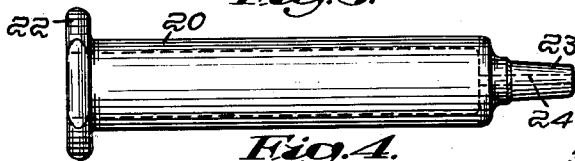


Fig. 4.



Fig. 5.



Fig. 9.

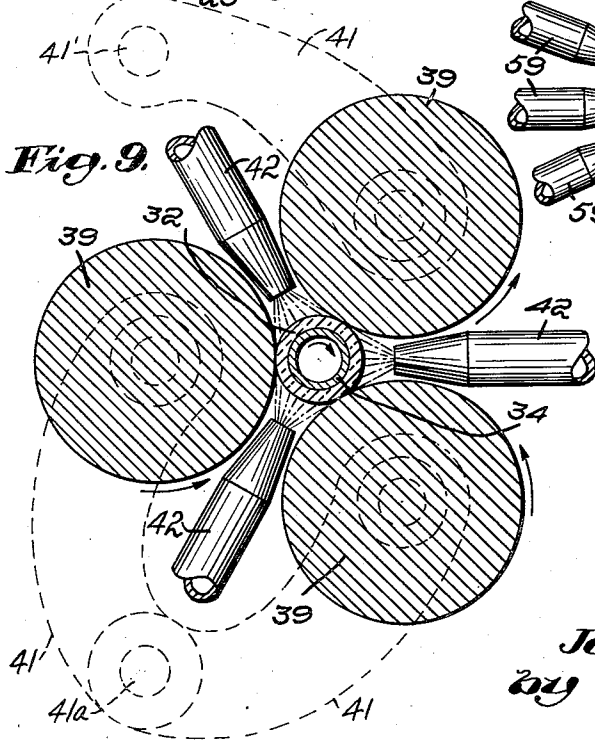
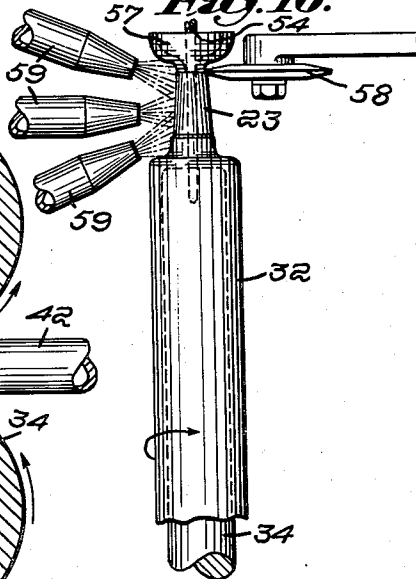


Fig. 10.



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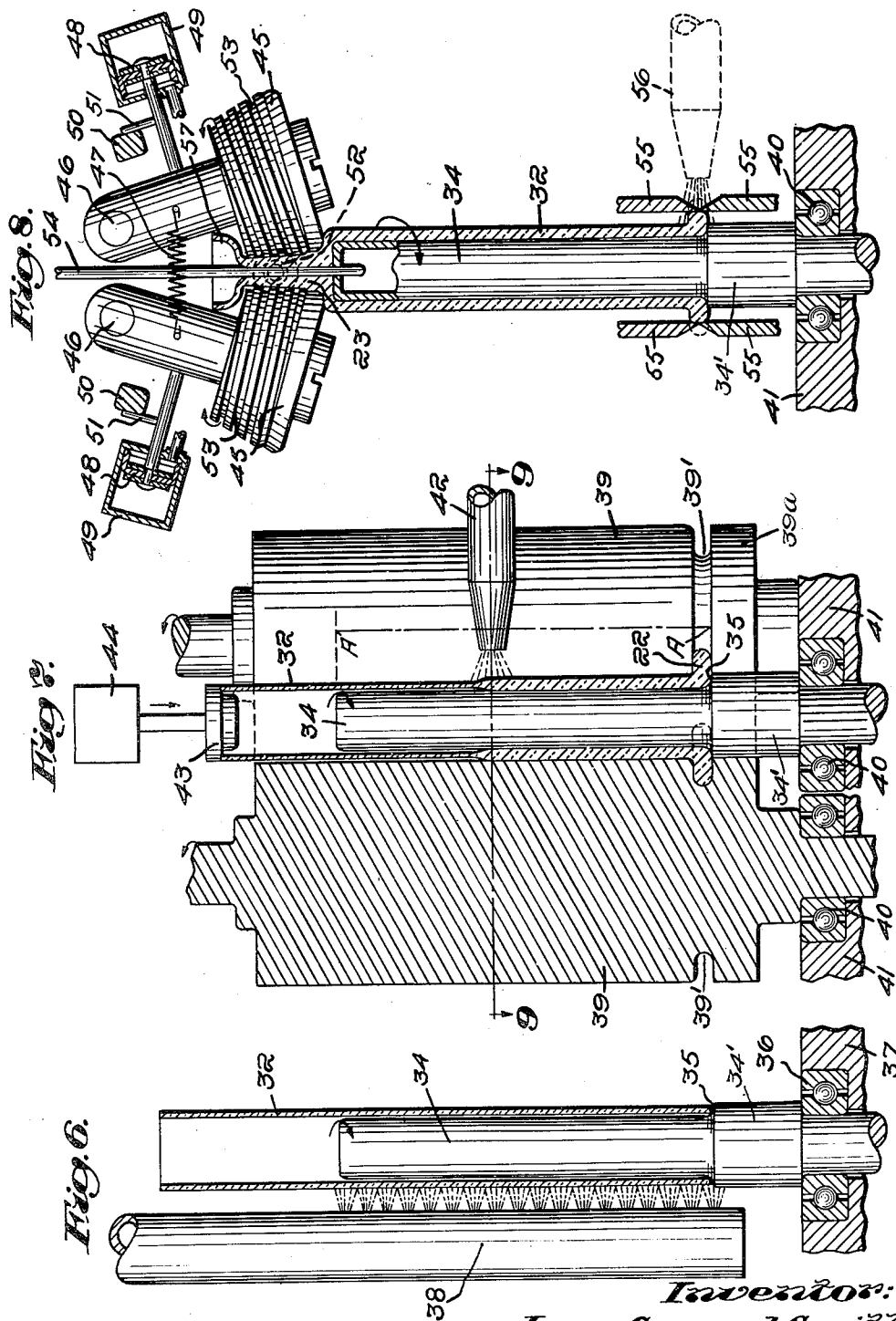
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FABRICATED GLASS ARTICLE AND METHOD

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3 Sheets-Sheet 2



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FABRICATED GLASS ARTICLE AND METHOD

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3 Sheets-Sheet 3

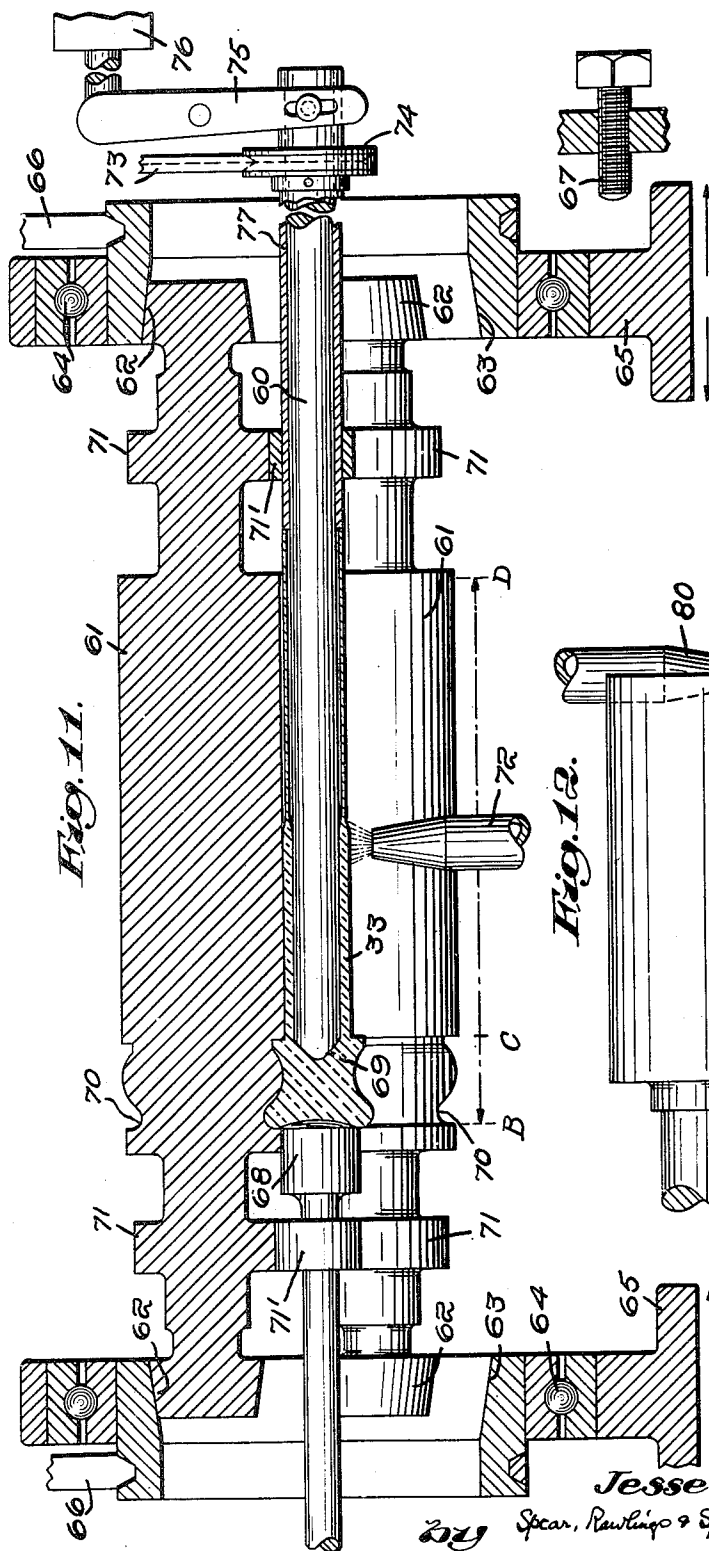
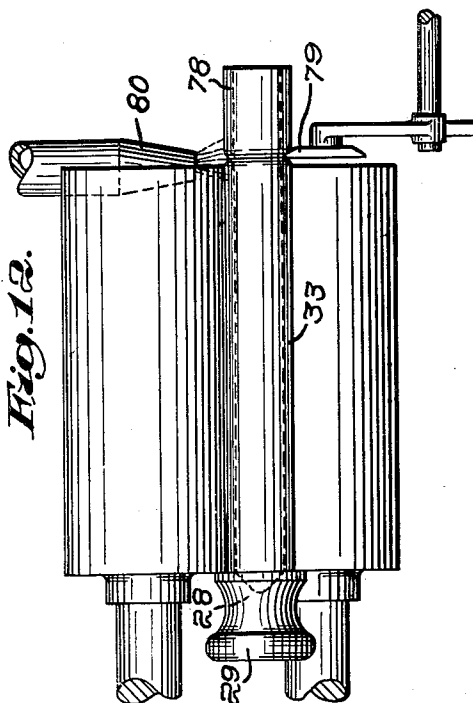


Fig. 11.

Fig. 12.



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2,392,104

FABRICATED GLASS ARTICLE AND METHOD

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Application December 10, 1941, Serial No. 422,411

10 Claims. (Cl. 128—218)

This invention relates to improvements in glass fabrication, and particularly to the fabrication from glass tubing of articles having closely interfitting relatively movable parts, as for example, the stationary barrel and sliding plunger of a hypodermic syringe, or the stationary shell and rotary valve of a stop cock.

In such articles, extreme accuracy of fit, amounting almost to perfection, is required between the mating parts.

The inside diameter of the commercial glass tubing used in the manufacture of such articles varies considerably, and this has resulted in the production of syringe parts which likewise varied in diameter and consequently had to be afterwards ground in order to bring them to an accurate fit.

Moreover, where the syringe parts are ground to a working fit, the portion of the plunger which fits within the barrel is necessarily of somewhat greater over-all length than the barrel. This frequently causes breakage of the barrel in the use of the syringe, due either to forcing the plunger so far into the barrel as to cause its inner end to strike with considerable shock against the forward end wall of the barrel, or to suddenly releasing the plunger after partly or fully retracting it from the barrel and allowing it to be drawn forwardly, by suction, against said end wall. In either case, the contact of the inner end of the plunger against the forward end of the barrel frequently causes breakage.

The main object of my invention is to fabricate the mating parts of a glass article to such close tolerances in the first instance that when assembled they will fit each other so perfectly as to make it unnecessary afterwards to subject them to grinding operations.

Other objects and advantages will appear as the description proceeds.

In carrying out my invention, I subject glass tubing of approximately the internal or external diameter required for the mating parts of the article to a series of firing and shaping operations which brings all coating surfaces of the mating parts fabricated from such tubing to the precise dimensions necessary to enable them exactly to fit one another without grinding. Simultaneously with the accurate dimensioning of the coating surfaces of the mating parts, I give such parts the configurations required for the finished article.

The exact fit which I obtain by my invention is a fired-fit and not a ground-fit. Being unground, the mating parts are of optimum mechan-

ical strength. Moreover, their mutually contacting surfaces which, by reason of their exact fit, afford the maximum pressure effect with the minimum friction coefficient in the use of the syringe or other fabricated article.

Syringe parts fire-fitted in accordance with my invention are cylindrical from end to end and fit each other to tolerances ranging from plus or minus .0001 of an inch, without grinding. Furthermore, such fit is uniform throughout the entire stroke of the plunger in the barrel. This insures that the full pressure effect of the plunger on the syringe content will be developed throughout its entire stroke, thereby eliminating objectionable leakage of the syringe content past the plunger.

My fire-fitted syringe parts do not exhibit any pronounced roughness, such as is caused by grinding, and hence operate more smoothly and with less friction than do ground-fitted parts. Moreover, the barrels are transparent so that the syringe content and its condition may be readily observed undimmed or undistorted by any ground surface.

Moreover, because my fire-fitted syringe barrels are each and every one alike, both in capacity and inside diameter, it is possible to apply standard dosage scale to each barrel by what is generally known as the "screen" process in which a silk or metallic screen is used to stencil a uniformly accurate scale on each and every barrel of like capacity. This obviates many tedious and costly operations of the engraving and etching process now currently employed, such as the necessity of measuring and determining the internal capacity of each individual barrel, plugging, waxing, engraving lines, engraving figures, engraving numbers, waxing, etching, stripping, cleaning, applying pigment, baking, etc.

For the purposes of this application I have described and illustrated my invention in connection with the fabrication of a hypodermic syringe of conventional type. It will be understood, however, that such treatment is purely illustrative and in no way limiting, since the principles of my invention are applicable to a wide variety of glass articles having closely interfitting relatively movable parts, as for example, bearings, stop cocks, injection nozzles for Diesel engines, and pump parts for the transfer of liquids and chemicals.

In the accompanying drawings:

Fig. 1 is a side elevation of a glass hypodermic syringe of conventional type fabricated in accord-

ance with my invention, the plunger being partly withdrawn.

Fig. 2 is a side elevation of the glass tubing or blank from which the barrel of such syringe was fabricated.

Fig. 3 is a side elevation of the fabricated barrel, prior to graduating the same.

Fig. 4 is a side elevation of the glass tubing or blank from which the plunger of such syringe was fabricated.

Fig. 5 is a side elevation of the fabricated plunger.

Figs. 6 to 10, inclusive, are diagrammatic views illustrating steps in fabricating the barrel shown in Fig. 3; Fig. 9 being a section on the line 8-8, of Fig. 7, and

Figures 11 and 12 are diagrammatic views illustrating steps in fabricating the plunger shown in Fig. 5.

Referring first to Figs. 1 to 5 inclusive, the hypodermic syringe illustrated in Fig. 1 is of Luer type. It comprises an unground fired glass barrel 20 externally graduated as at 21, and flanged at one end as at 22 and having at its opposite end a reduced conical tip 23 provided with an axial bore 24 connecting with the interior of the barrel.

Slidable within the barrel is an unground fired glass plunger 25 which is preferably hollow as indicated at 26 between its sealed inner and outer ends 27 and 28. The outer end of said plunger is enlarged to provide an operating head 29, and said head is shaped to provide a shoulder 29' at its inner end for contact with flange 22 of the barrel when the plunger is fully inserted in the barrel thereby to limit the inward stroke of the plunger. The over-all length of the barrel-fitting portion of the plunger, as compared to that of the barrel, is such that when the plunger is fully inserted in the barrel, its inner end is slightly spaced away from the forward end of the barrel by the contact of shoulder 29' with flange 22, thus avoiding the danger of breaking the barrel by careless operation of the plunger.

Detachably mounted on the tip 23 of the barrel is a hollow hypodermic needle 30 of conventional type provided with the usual finger-grasping hub 31.

The barrel and plunger of my syringe are characterized in that they are fabricated by heat and pressure to such close tolerances as to accurately fit one another without the necessity of afterwards grinding either or both of them to a fit.

In accomplishing this result I start with a supply of glass tubing or blanks 32 for the barrels, and a supply of glass tubing or blanks 33 for the plungers.

The barrel blanks 32 and the plunger blanks 33 are both of greater over-all length than the fabricated barrels and plungers (see Figs. 2 and 3 and Figs. 4 and 5) so as to assure sufficient glass for the formation of the flanges 22 and tips 23 of the barrels and the heads 29 of the plungers when the blanks are heat-softened and fabricated to barrel or plunger shape.

Referring to Figs. 6 and 10 inclusive wherein the successive steps in fabricating my barrels are diagrammatically illustrated, Fig. 6 shows a barrel blank 32 being subjected to a pre-heating operation.

The blank is positioned on and rotates with a rotatable arbor 34 of suitable material and of an external diameter exactly corresponding to the internal diameter to which the blank is to be brought. Arbor 34 is shouldered as at 35 to sup-

port the lower end of the blank and is rotatably mounted as at 36 in a suitable support 37.

A ribbon burner 38, or its equivalent, positioned adjacent the arbor continuously bathes the blank in flame as the arbor and blank are rotated relative thereto at predetermined speed. Burner 38 is preferably mounted in fixed relation to the arbor and blank and the intensity of the flame which is supplied is only sufficient to pre-heat the blank to the point where the glass can be quickly softened when ready to be worked.

Fig. 7 illustrates the next step in my method. In this step, the flange 22 is formed on the preheated blank, while the blank is being sized to the exact external diameter of the arbor 34. In this action, the arbor 34 with the preheated blank thereon, is introduced axially, or otherwise, between a plurality of radially spaced sizing rolls 39 (here shown as three) which are at least coextensive in length with the arbor. Rolls 39 are rotatably mounted as at 40 in suitable supports 41 and rotate at predetermined speed in a direction counter to that of the rotating arbor and blank (Fig. 9). There is a support 41 for each roll 39. The supports 41 are in the form of pivoted arms. One of said arms is pivoted as at 41'. The other two arms are pivoted on a common pivot 41a (see Fig. 9). All arms are opened and closed as a unit by any suitable mechanism (not shown). Arbor 34 has a sizing portion 34' against which sizing portions 39a of rolls 39 friction. The sizing roller 34' fixes the distance that rolls 39 are spaced apart as well as imparting rotation to said rolls when in contact therewith.

Flames from burners 42 located in the spaces between said rolls 39 and traversing the blank from end to end of the arbor, as indicated by the line A-A in Fig. 7, progressively soften the rotating blank beginning adjacent shoulder 35 so that it may be freely worked.

At the same time axial pressure is exerted on the upper end of the rotating blank by a plunger 43 which is preferably sized to enter the open upper end of the blank. Any suitable pressure means, as the conventionally indicated weight 44 may be employed for continuously forcing plunger 43 against the upper end of the blank so that it may follow the blank downwardly as the blank softens and its length diminishes.

The rolls 39 have registering grooves 39' therein of a depth and shape to form a flange of the required size and shape on the lower end of the blank as the softened glass is forced into said grooves under the end pressure of plunger 43.

In this action the shoulder 35 of the arbor limits the flow of the softened glass downwardly and the peripheries of the rolls 39 limit the flow thereof outwardly to give the blank the required outside diameter as determined by the sizing roller 34' which fixes the distance that the rolls 39 are maintained apart. Because of the flow of the softened glass under pressure, the internal diameter of the blank is caused to correspond exactly to the outside diameter of the arbor throughout the length of the arbor.

This sizing and shaping action is continued until flange 22 has been formed, the side wall of the blank brought to substantially uniform thickness, and the inside diameter of the blank brought to the exact outside diameter of the arbor, except at the extreme upper end of the blank where the tip 23 is to be formed (Fig. 8).

At this time, the arbor with the partly fabricated blank still thereon is moved into position to be acted upon by a plurality (preferably three)

of radially spaced tip-shaping rolls 45. These are pivoted as at 46 and are opened and closed relative to the tip 23 in any suitable manner. As shown in Fig. 8, they are closed on the tip by means of coiled springs 47 and are opened against the action of said springs by pistons 48 operating in air or other cylinders 49. Fixed stops 50 arranged in the path of projections 51 on the stems of said pistons limit the closing movement of the rolls.

Located in the spaces between the rolls 45 are burners 52 for continuously bathing the tip 23 in softening flame while the rolls are at work.

The rolls 45 are rotated by frictional contact with the tip portion of the rotating blank, but in the opposite direction thereto. They are preferably exteriorly threaded as at 53 to insure that they will work the softened glass down to the conical tip form shown, and may be opened and closed relative to the tip as many times as necessary to achieve this result.

Before the rolls 45 are first closed upon the work, a rod 54 of wire or the like is inserted endwise from above through the softened glass of the tip to reinforce the tip while it is being worked and to form the axial bore 24 therein. This rod is held stationary by any suitable means relative to the rotating tip, remains within the tip until the tip is completely formed and the excess glass 57 cut off (see Fig. 10) and is then withdrawn by appropriate mechanism operating in time with the related parts of the barrel machine.

After the tip is completed, the flange 22 may be slabbled off at its opposite edges (to prevent the barrel from freely rolling when laid down). For convenience of illustration, this operation is shown in Fig. 8 as being performed at the time that the tip is formed, although it is actually performed at a subsequent step in the cycle of the barrel machine. Pairs of coating cutters 55 at opposite sides of the rotating blanks are simultaneously closed upon opposite edges of the flange 22 while the flange is bathed in a softening flame from a burner 56 which also smoothes the slabbled off edges of the flange.

In the same or a subsequent step in the machine cycle, the excess of glass 57 left above the formed tip 23 is trimmed off the rotating blank by means of a rotating cutter 58 (Fig. 10) while the tip and excess of glass 57 are bathed in a softening flame from one or more burners 59 which also smooth the tip.

The forming of the barrel is now completed and when it and the arbor are sufficiently cooled, the barrel is stripped from the arbor.

The plungers are fabricated in a manner generally similar to that described for the barrels. This is illustrated diagrammatically as in Figs. 11 and 12 wherein a plunger blank 33 is shown as supported on and rotating with an arbor 60 which has been entered endwise (from the right in Fig. 11) thereinto. Arbor 60 is adapted to be positioned between a plurality (preferably three) of spaced sizing rolls 61 substantially coextensive in length with the blank.

Rolls 61 are formed at their ends with tapered surfaces 62 for engagement with the correspondingly tapered surfaces of rotating rings 63 which are supported through anti-friction bearings 64 on brackets 65 and are rotated in any suitable manner as by driving belts 66.

Brackets 65 are movable longitudinally towards and away from each other, as indicated by the arrows in Fig. 11 by any suitable means as an oil cylinder and pistons (not shown) lo-

cated between said brackets. Adjustable stops of which one is shown at 67 limit the separating movement of the brackets.

When rolls 61 are at work, the inner end of the blank abuts a stop 68 located between rolls 61 and aligned with arbor 60. The inner end of the arbor stops at a point 69 within the blank sufficiently removed from stop 68 to seal off the end 28 of the plunger 25 and with the appropriately shaped grooves 70 of the rolls 61 to form the enlarged plunger head 29.

Rolls 61 are formed between their ends with annular portions 71 which bear on sizing rolls 71' loosely centered on the stem of the end stop 68 and the end pressure device 77, respectively, thereby to determine the outside diameter of the fabricated plunger by fixing the distance that rolls 61 are maintained apart along the length of the blank.

Mounted in the spaces between rolls 61 are longitudinally traveling burners of which one is indicated at 72. These traverse the blank in successive passes. During formation of the plunger head 29 they travel from point B to point C. When the head is completed, they traverse the blank from point C to point D. These movements are imparted to the burners by any suitable cam or the like (not shown).

Arbor 60 is rotated by belt 73 and pulley 74 and is entered into and withdrawn from the blank by any suitable mechanism as lever 75 and air cylinder 76.

End pressure is exerted on the softened blank by means of a pressure tube 77 sleeved about the arbor adjacent its outer end and constantly fed towards the blank as the blank diminishes in length by means of any suitable weight or spring controlled follower or the like (not shown).

After the blank has been fabricated to the size and shape desired, the excess of glass 78 at the end thereof remote from the head 29 is cut off and the end sealed over. This step is illustrated in Fig. 12, wherein a rotating cutter 79 is shown at work while this region of the blank is bathed in flame from a burner 80.

From the foregoing description taken in connection with the drawings, it will be evident that I have provided a method of sizing and shaping the mating parts of glass syringes and other articles to such extremely close tolerances as to avoid any necessity for grinding them to a fit after they have been fabricated by heat and pressure.

Although I have described the barrels and plungers as both being fabricated of glass, it is possible in some types of syringe and for certain applications to use plungers of materials other than glass so long as they are used in connection with my barrels which are all of uniform diameter throughout their length.

Particular attention is called to the fact that the area of the blank covered by the impinging flames from the traveling burners 42 or 72 at any time is a relatively narrow zone or band. This progressively softened area of glass reacts to the heat and the pressure of the plungers 43 or 77 to form a perfectly smooth and accurately sized tube.

In order to avoid objectionable twisting or other distortion of the glass while the rolls are at work, however, the temperature of the glass, arbor, and rolls must all be properly related to the surface speed of the arbor and rolls and to the degree of end-pressure exerted on the softened blank by the pressure devices 43 or 77.

By preheating the blank, I prepare it for the high temperature flames from the several burners 42, 52, 72, etc., thus avoiding fire shock breakage.

The use of three symmetrically spaced sizing rolls enables me to best relate the periods of heating and cooling to each other and thereby avoid distortion of the glass during such periods. It also enables me to more closely control the sizing operation. For tubing of extra large diameter, however, I may add a fourth roll.

Instead of traversing the burners 42 and 72 longitudinally relative to the rotating arbor and blank, the burners might be stationary and the arbor and blank arranged to slide relative thereto, in which case the length of the rolls could be substantially reduced.

Where necessary the rolls 39 or 61 may be exteriorly threaded similar to the threads 53 of the rolls 45 to facilitate their engagement with the blank.

Various other modifications in article and method may obviously be resorted to within the spirit and scope of my invention as defined by the appended claims.

What I therefore claim and desire to secure by Letters Patent is:

1. A hypodermic syringe comprising a glass barrel and a mating glass plunger, said barrel having a bore which is of predetermined inside diameter and is uniform throughout its length and said plunger having a barrel-entering portion which is of predetermined outside diameter and is uniform throughout its length so that any circumferential part of said barrel-entering portion forms an effective seal with any circumferential portion of the barrel bore throughout the working stroke of the plunger within the barrel, the inner surface of said barrel and the outer surface of said barrel-entering portion each being in the form of a skin of the smoothness and strength characteristic of unground glass.

2. The syringe of claim 1, the barrel having a perforated wall at its forward end and being open at its rear end and there being provided with an external flange, the plunger having an enlarged head disposed beyond the open end of said barrel for contact with said flange, and the over-all length of the barrel-entering portion of the plunger being so related to the over-all length of the barrel bore that in the use of the syringe the plunger head contacts said flange and stops the forward travel of the plunger at a point slightly spaced away from the forward end wall of the barrel thereby to avoid breakage of said forward end wall by contact of the forward end of the plunger therewith.

3. A glass article comprising a hollow glass cylinder and a mating glass male element, said cylinder having a bore which is of predetermined inside diameter and is uniform throughout its length and said male element having a bore-entering portion which is of predetermined outside diameter and is uniform throughout its length so that any circumferential part of said bore-entering portion forms an effective seal with any circumferential portion of the bore throughout the working stroke of the bore-entering portion within the cylinder, the inner surface of said cylinder and the outer surface of said bore-entering portion each being in the form of a skin of the smoothness and strength characteristic of unground glass.

4. The method of claim 8, and the further

steps of moving the arbor with the partly-finished blank thereon to a centered position between a set of radially-spaced rotating tip forming rolls shaped to produce a tapered tip on the outer end of the blank, introducing a bore-forming wire in the tip portion of the blank, closing said tip-forming rolls on the tip portion of the blank, directing softening flame on said tip portion of the blank while simultaneously rotating said arbor and said tip-forming rolls relative to each other, and finally opening said tip-forming rolls, withdrawing said bore-forming wire and removing the finished article from the arbor.

5. The syringe of claim 1, the external surface of the barrel being provided with a longitudinal scale of graduations which is standard as to its over-all length and the spacing of its graduations for all like barrels of like diameter measurement.

6. The method of making a glass article of accurate external diameter, which comprises axially supporting a tubular blank on a rotating arbor between a plurality of radially spaced sizing rolls defining the desired external diameter of the finished article, and with the inner end of said blank abutted against a fixed stop, rotating said supported blank and said rolls relative to each other while simultaneously softening the blank by applying a flame progressively from the inner end toward the outer end of the blank, and continuously exerting end pressure on the outer end of said blank to press the softened blank against said fixed stop and rolls until an article of the desired external diameter is obtained.

7. The method of making a glass article of accurate internal and external diameter which comprises supporting a tubular glass blank on a rotating arbor of the diameter wanted for the inside of the finished article between a plurality of sizing rolls radially spaced to define the desired external diameter of the finished article and with the inner end of said blank abutted against a fixed stop, relatively rotating said arbor and rolls and simultaneously subjecting the blank to a softening flame applied progressively from the inner end of the blank towards its outer end while exerting continuous end pressure on said outer end of said blank to press the softened blank against said fixed stop, said rolls and said arbor and thereby bring the inside diameter of the blank to that of the arbor and the outside diameter of the blank to that of a circle externally tangent to the rolls.

8. The method of making a glass article of accurate internal and external diameters, which comprises supporting a tubular glass blank on a rotating arbor of the diameter wanted for the inside of the finished article between a plurality of radially spaced rotating sizing rolls, said arbor having a shoulder constituting a fixed stop for the inner end of the blank and adjacent said shoulder having a sizing portion, and said sizing rolls having portions for engagement with said sizing portion of said arbor so that said sizing rolls will define the outside diameter of the finished article, rotating said blank and said rolls relative to each other, and simultaneously subjecting the blank to a softening flame applied progressively from the inner end of the blank towards its outer end while continuously applying end pressure to the outer end of said softened blank to upset the glass and press it against said fixed stop, said rolls and said arbor.

9. A glass hypodermic syringe barrel for use

with a mating plunger having a predetermined outside diameter which is uniform throughout its barrel-entering portion, said barrel having a bore which is of predetermined inside diameter and is uniform throughout its effective length so that any circumferential part of said bore will form an effective seal with any circumferential part of the barrel-entering portion of the plunger throughout the working stroke of the plunger within the barrel, the inner surface of said barrel being in the form of a skin of the smoothness and strength characteristic of unground glass.

10. A glass hypodermic syringe plunger for

5 use with a mating barrel having a predetermined inside diameter which is uniform throughout its effective length, said plunger having a barrel-entering portion the outside diameter of which is uniform throughout its effective length so that any circumferential part thereof will form an effective seal with any circumferential part of the barrel bore throughout the working stroke of the plunger within the barrel, the outer surface of the barrel-entering portion of the plunger being in the form of a skin of the smoothness and strength characteristic of unground glass.

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