July 27, 1954 H. G. MOLINARI 2,684,556

MACHINE AND METHOD FOR FORMING SYRINGE BARRELS

Original Filed June 12, 1948 4 Sheets-Sheet 1

Fig. 1

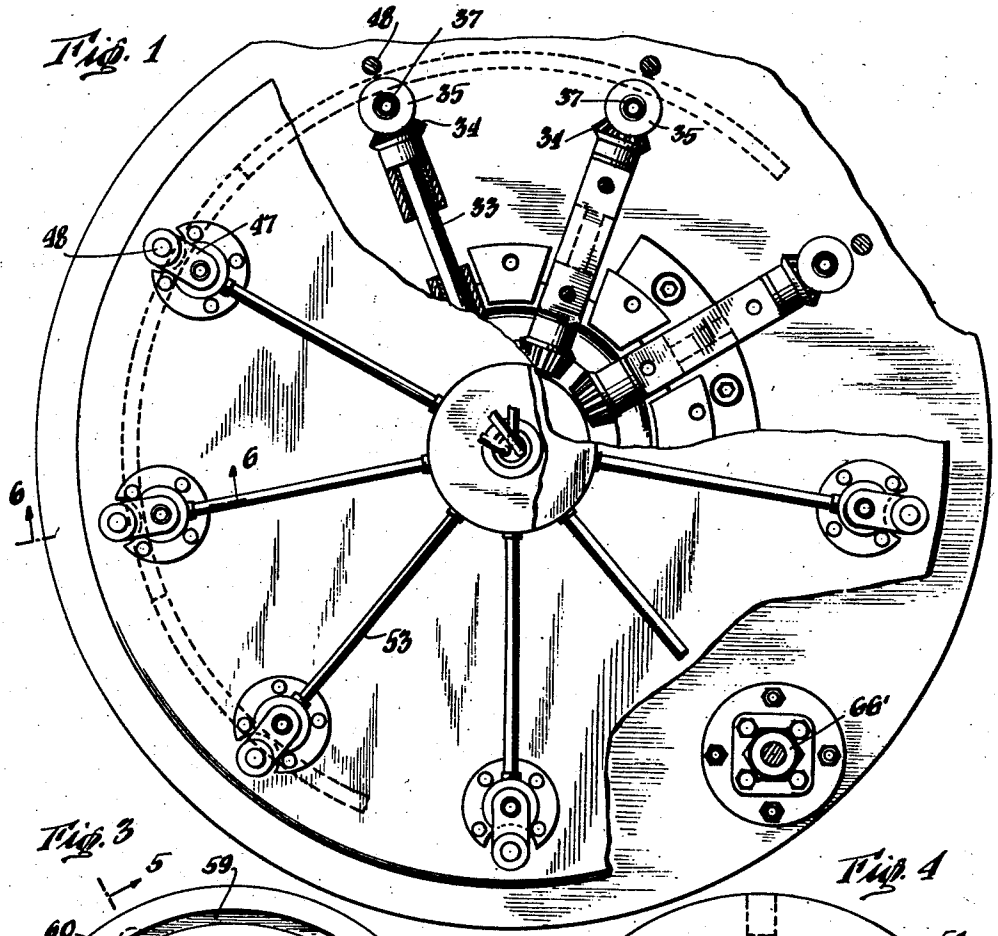


Fig. 3

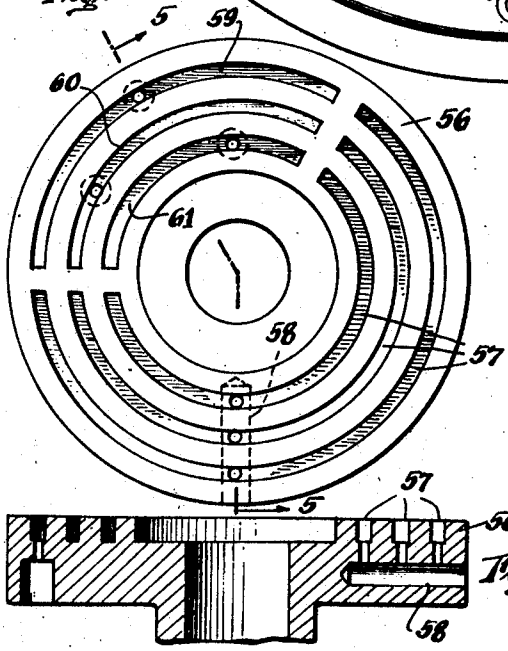


Fig. 4

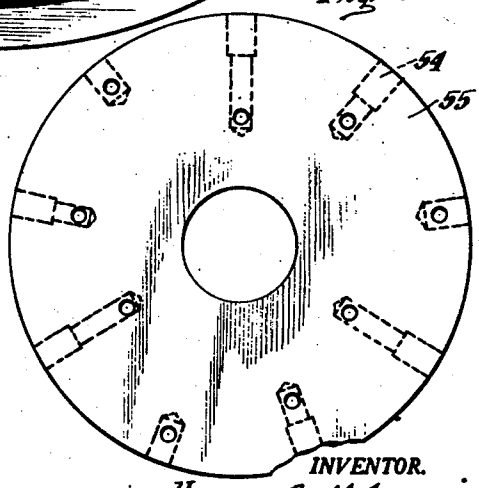


Fig. 5

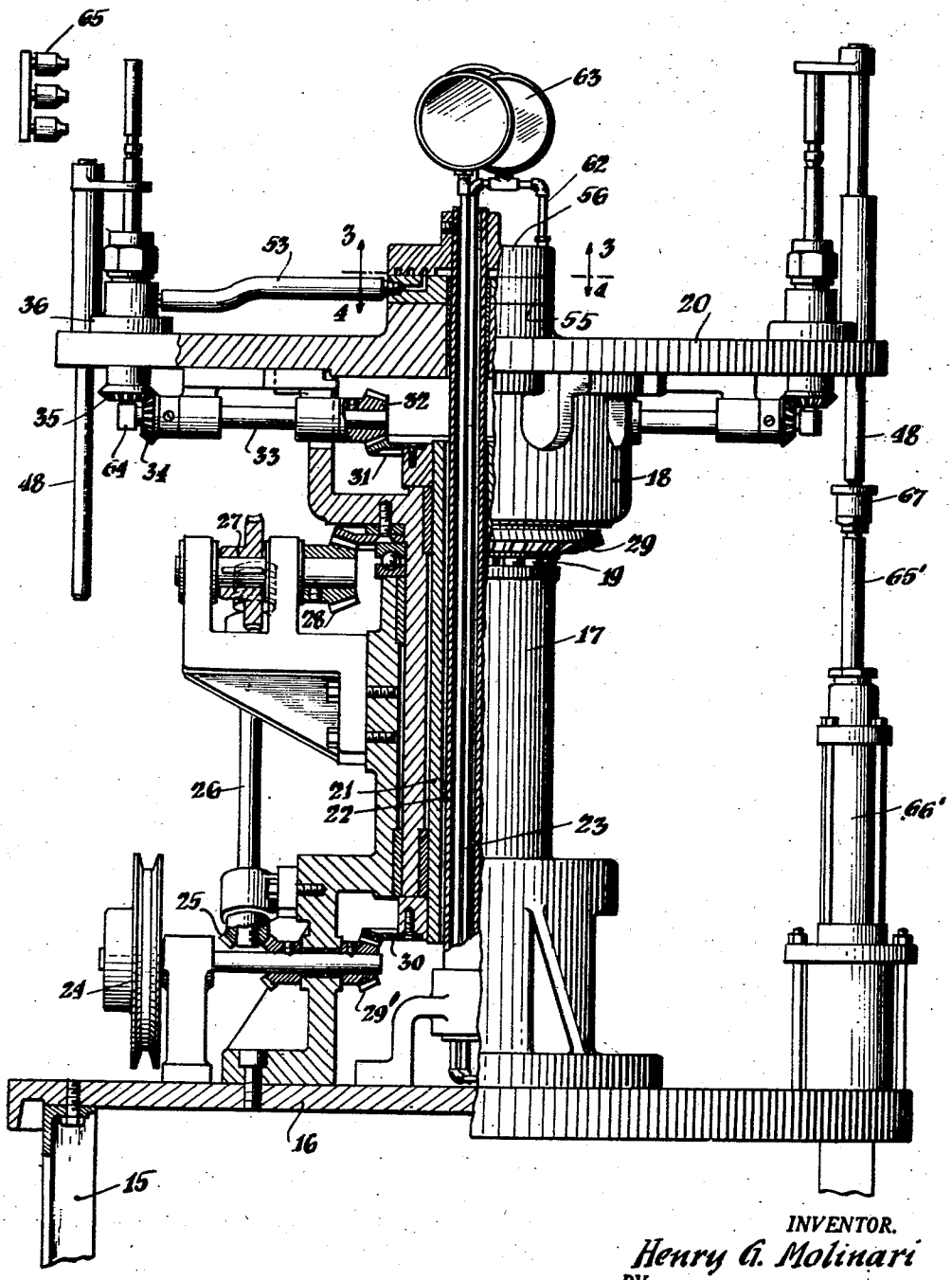
INVENTOR.
Henry G. Molinari
BY Kane, Dalsimer and Kane
Quill and Kane
ATTORNEYS

July 27, 1954 H. G. MOLINARI 2,684,556

MACHINE AND METHOD FOR FORMING SYRINGE BARRELS

Original Filed June 12, 1948 4 Sheets-Sheet 2

Fig. 2



INVENTOR.
Henry G. Molinari
BY
Dabbadt Kane
Kane, Dalsimer and Kane
ATTORNEYS

July 27, 1954 H. G. MOLINARI 2,684,556

MACHINE AND METHOD FOR FORMING SYRINGE BARRELS

Original Filed June 12, 1948 4 Sheets-Sheet 3

Fig. 6

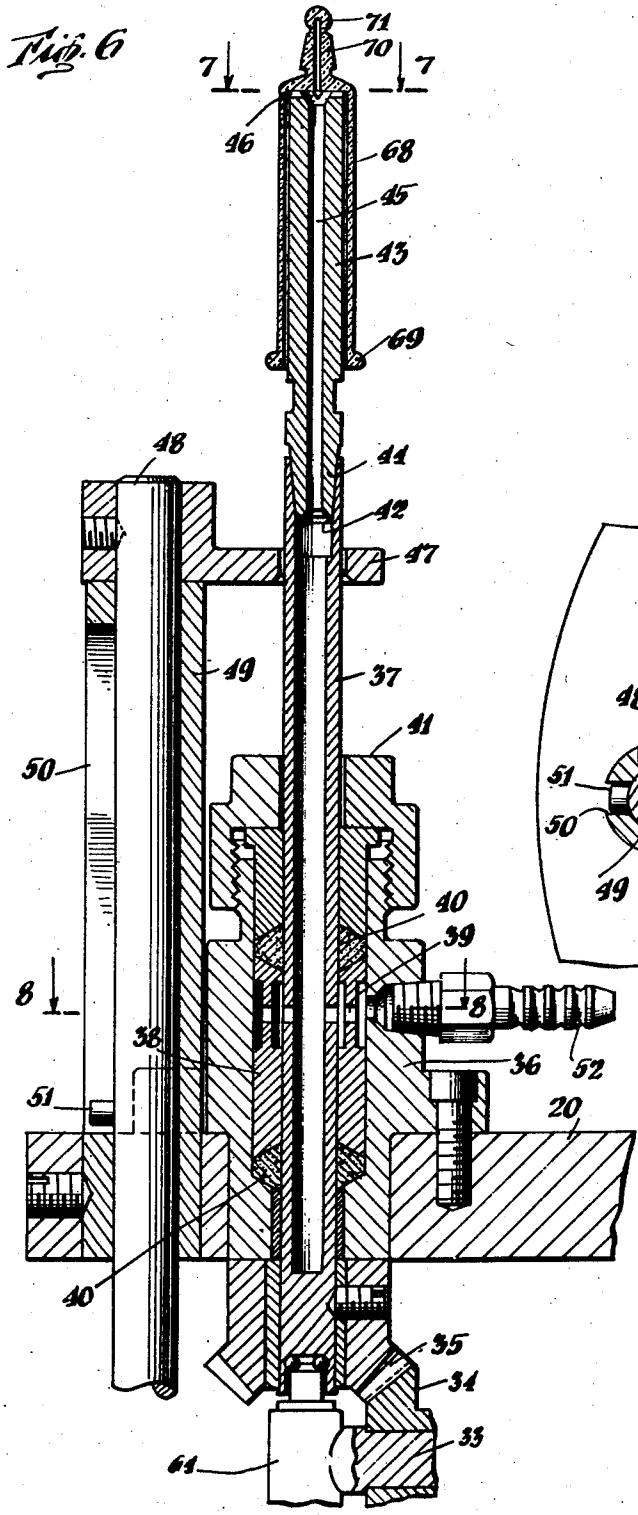


Fig. 7

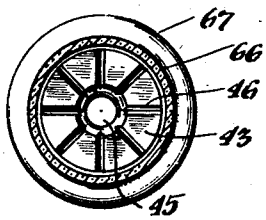
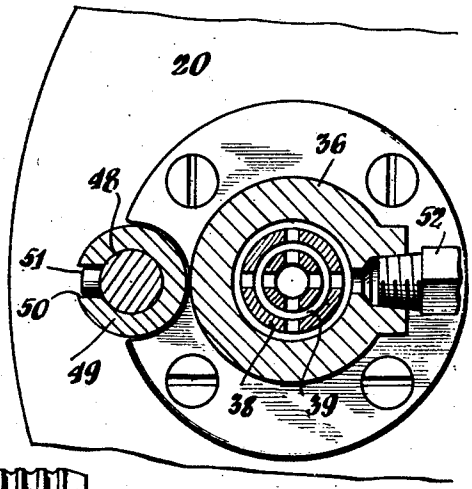


Fig. 8



INVENTOR.
Henry G. Molinari
BY Dodd and Kane
Kane, Dunham and Kane
ATTORNEYS

July 27, 1954 H. G. MOLINARI 2,684,556

MACHINE AND METHOD FOR FORMING SYRINGE BARRELS

Original Filed June 12, 1948 4 Sheets-Sheet 4

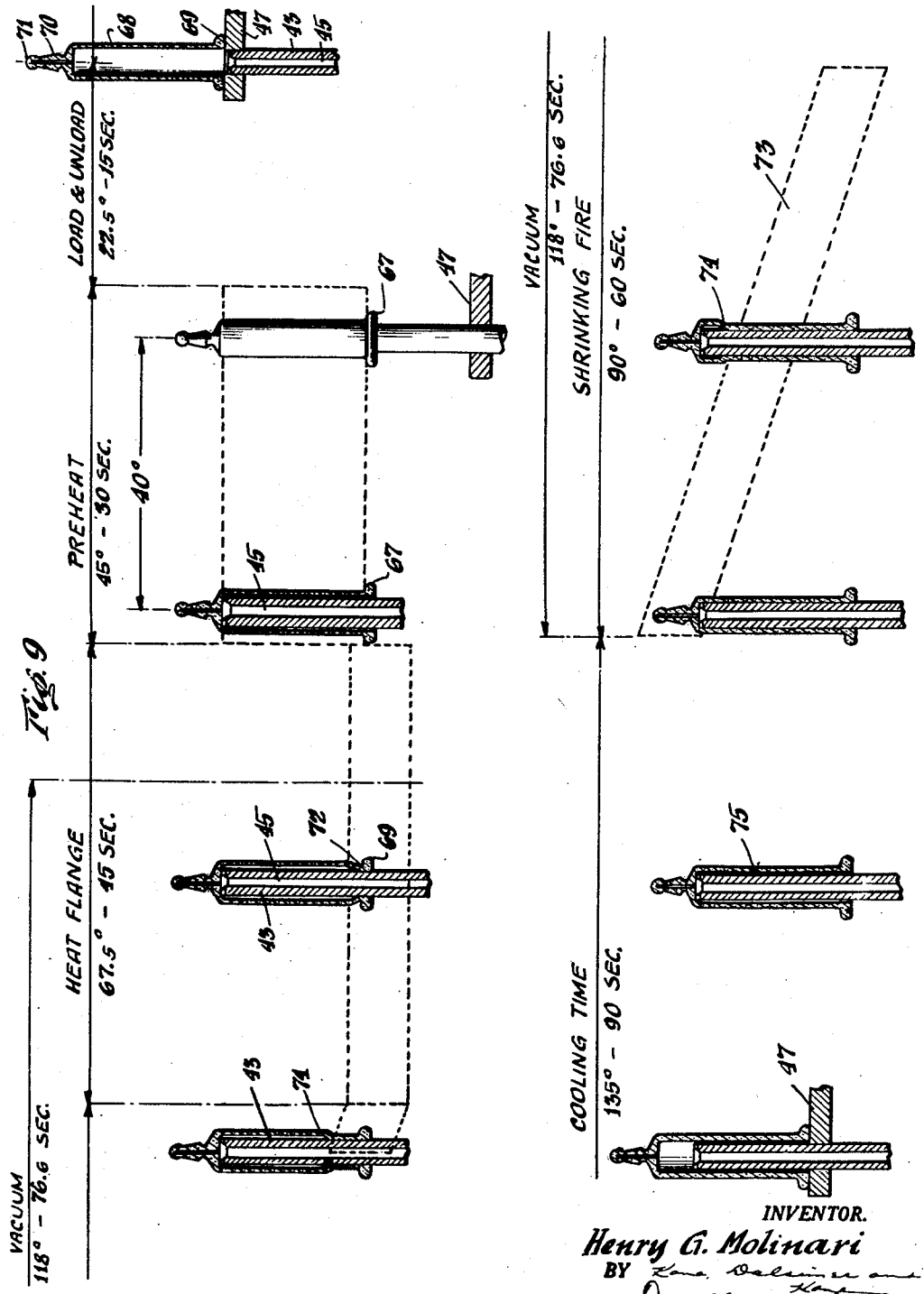


Fig. 9

INVENTOR.
Henry G. Molinari
BY Kane, Dalimore and Kane
Dunbar and Kane
ATTORNEYS

Patented July 27, 1954

2,684,556

UNITED STATES PATENT OFFICE

2,684,556

MACHINE AND METHOD FOR FORMING SYRINGE BARRELS

Henry G. Molinari, Rutherford, N. J., assignor to Becton, Dickinson and Company, Rutherford, N. J., a corporation of New Jersey

Continuation of application Serial No. 32,660, June 12, 1948. This application February 18, 1953, Serial No. 337,526

21 Claims. (Cl. 49—7)

1

This invention relates to a structurally and functionally improved machine by means of which syringe barrels and similar units are provided and also aims to teach a novel method for the production of units of this character.

This application is a continuation of my prior application for United States Letters Patent Serial Number 32,660 filed June 12, 1948 (now abandoned).

As is well understood by those conversant with the manufacture and use of hypodermic syringes, an all glass assembly is, in many respects, to be preferred. In other words, the assembly should include not alone a glass barrel or cylinder, but also a piston or plunger rod of glass slidable within that barrel. By movement of the latter, not alone may medicament be expelled from the barrel for purposes of injection, but also that medicament may be drawn into the cylinder to charge the syringe with a suitable quantity of desired liquid.

Such syringe assemblies have been relatively expensive to manufacture. This has largely been because the barrel and plunger have had to be accurately fitted to one another so that proper expelling pressures could be produced for injection purposes without having the medicament excape between the surfaces of the piston and cylinder. Also, it has been necessary in aspirating or charging operations to be certain that an adequate suction would be maintained under retractive movement of the piston and without danger of air leakage between the parts partially breaking the suction.

The fitting of the barrel to the plunger involves a relatively large expense; it being necessary to resort to a selection of barrels of one size in relation to the material from which the plungers were to be formed. Thereafter numerous operations and testing steps follow in order that a proper assembly results and which will pass inspection. However, unless further time consuming and expensive techniques are resorted to, the barrel is usable with only the particular plunger selected for the same. In other words, it is not generally practicable with a series of assemblies to interchangeably employ the barrels and plungers one with the other. Moreover, due to the fitting and finishing operations aforementioned, the bore of the barrel has imparted to it a somewhat satiny finish. This, in certain instances, is undesirable in that the barrel no longer presents a clear glass body through which its interior and contents may readily be observed.

2

With the foregoing in mind, it is a primary object of the invention to teach a simple inexpensive method of forming syringe barrels in a manner such that they will properly fit and cooperate with plunger rods of a predetermined stock size; the present invention also embracing a machine by means of which this method may be economically practiced. Therefore, it will be feasible to produce syringe assemblies of all glass type in relatively large quantities and at small cost. These assemblies will have their parts interchangeable so that it will be unnecessary to, for example, identify the barrel and plunger by identical serial numbers.

A further object is that of providing an all glass syringe assembly, in which the barrel will not be as subject to breakage as assemblies heretofore produced and which will not be subject to erosion. Moreover, such an assembly will permit a clear observation of the medicament within the barrel and a substantially complete expulsion of that medicament by fully projecting the plunger.

Another object is that of teaching a simple method of procedure and providing a machine involving relatively few and individually rugged parts. These parts, when assembled, will operate over long periods of time with freedom from all difficulties and, moreover, when a renewal of certain parts is necessary this may be accomplished with substantially no interruption to the operation of the machine.

With these and other objects in mind, reference is had to the attached sheets of drawings illustrating a practical embodiment of the invention and in which:

Fig. 1 is a top plan view of the machine with certain of the parts broken away to disclose underlying construction;

Fig. 2 is a partly sectional side view of the machine;

Figs. 3 and 4 are sectional views taken along the lines and respectively in the direction of the arrows 3—3 and 4—4 as shown in Fig. 2;

Fig. 5 is a transverse sectional view taken along the lines 5—5 and in the direction of the arrows as indicated in Fig. 3;

Fig. 6 is a fragmentary enlarged sectional view taken along the lines 6—6 and in the direction of the arrows as indicated in Fig. 1;

Figs. 7 and 8 are transverse sectional views taken along the lines 7—7 and 8—8 and in the direction of the arrows as respectively indicated in Fig. 6; and

Fig. 9 diagrammatically illustrates the se-

quence of steps involved in the treatment or formation of the syringe barrel.

With primary reference to Fig. 2, the numeral 15 indicates a support which may mount a deck or platform portion 16. Secured to the latter is a standard 17 above which a head 18 may be rotatably mounted by anti-friction bearings 19. The head 18 conveniently supports a turntable 20. The standard 17 is hollow. Disposed to rotate within the same is a sleeve 21 which encircles a stationary tube 22. The latter serves as a housing for pipes 23 which—as hereinafter brought out—are preferably three in number. These pipes are connected one to each of a series of vacuum pumps (not shown).

With a view to rotating the head 18 and turntable 20, a drive such as that indicated by the numeral 24 may be employed. This drive, by means of gearing 25, rotates shaft 26 to turn a worm and worm wheel assembly 27 and a gear 28. The teeth of the latter mesh with the teeth of a gear 29 secured to the head 18. It therefore follows that with an operation of the drive 24 the turntable will be revolved. At this time it is also to be noted that, for example, by means of a gear 29' rotated by the drive 24 a gear 30 is turned. This gear is affixed to the sleeve 21 within standard 17. Therefore that sleeve is rotated. Such rotation causes a driving of gear 31 affixed to the upper end of the sleeve. A series of assemblies conveniently affixed to the under face of the turntable 20 are driven by gear 31. Each of these assemblies may include a gear 32, a shaft 33 affixed thereto and serving to rotate a gear 34, the teeth of which mesh with a gear 35. Accordingly the latter is in each assembly turned as the drive 24 is operated.

As especially shown in Fig. 1, nine mandrel assemblies are associated with the turntable 20. As will be apparent, a greater or lesser number of these assemblies might be employed. Each of these terminate adjacent its lower end in the gear 35 which, as aforedescribed, is driven by a gear 34 secured to rotate with a shaft 33. As especially shown in Fig. 6, each assembly may be mounted on the upper face of the turntable by securing a collar or support 36 to the turntable. This collar conveniently extends into an opening formed through the table. A tube 37 extends through the collar 36 and is secured against movement with respect to the gear 35. A bearing member 38 is interposed between the tube 37 and the collar 36. This member is formed with air-distributing passages 39. Packing as indicated at 40 may be disposed adjacent the opposite ends of the member. A substantially air-tight seal is furnished for example by employing a cap 41 having screw-threaded connections with the collar 36. When this cap is tightened and due to the configuration of the parts, the packing will be compressed to assure this result.

Adjacent its upper end tube 37 may be provided with a flared surface 42. A mandrel having a cylindrical forming surface 43 is provided with an extended and tapered lower end 44 seating against this surface. As a consequence of this construction, air leakage is prevented at this point. Also, the mandrel 43 will turn as a unit with tube 37. The mandrel is formed with a bore 45 forming a continuation of the tube bore. Adjacent its upper end, it is provided with a series of radially extending grooves or passages, 46. At this time it is to be noted that there is preferably provided as part of each of the assemblies an apertured member 47 through the opening of

which tube 37 extends. This member is supported by a rod 48 guided for movement by a sleeve 49. In order to prevent rotation of these parts with respect to each other, sleeve 49 may be formed with a slot within which a pin 51 mounted by the rod extends. As illustrated, the lower end of rod 48 projects below the lower face of the turntable 20.

Mounted one by each of collars 36 are fittings 52. As will be clear from Figs. 6 and 8 these fittings permit of the establishment of a vacuum from the interior of tube 37 through the passages of bearing member 38 and thence to the bore of fitting 52. Connected to the inner ends of each of these fittings are tubes or pipes 53 as shown in Figs. 1 and 2. The inner ends of these tubes are in turn connected to the adjacent passages 54 of a plate 55 as illustrated in Fig. 4. This plate is secured to rotate with the turntable 20. In the embodiment under consideration, passages 54 are divided into three series of three each. Each of the passages of one series extends to a different depth into the body of plate 55 as clearly shown in Fig. 4. Plate 55 is overlain by a plate 56 as shown in Fig. 2. The detailed structure of the plate 56 is illustrated in Figs. 3 and 5. As especially shown in these figures, arcuate grooves 57 extend throughout a major part of the plate face and are connected, for example, by a common passage 58 to be vented to the outer atmosphere. Arcuate grooves 59, 60 and 61 are also formed in the face of plate 56. They have radii corresponding to the radii of grooves 57. However, they are not connected to the former grooves. Preferably, each of grooves 59, 60 and 61 are 118° in length for a purpose hereinafter brought out. In any event, these grooves and the grooves 57 are disposed at different distances from the center axis of the machine and which distances correspond to the depth of the three successive passages 54 of each series in plate 55. Accordingly, with the plates in face to face contact as in Fig. 2, the passages 54 of the different series will successively traverse one each of the grooves 57 and thereafter grooves 59, 60 and 61 respectively. As shown especially in Figs. 2 and 5 branchlines 62 have their inner ends connected one to each of the pipes 23, their outer ends being respectively connected to passages 59, 60 and 61. Conveniently vacuum gages 63 are disposed one within each of lines 62.

Thus it will be understood that with drive 24 operating turntable 20—together with the assemblies carried thereby—will be revolved. Also each of the shafts 33 will rotate to drive gears 34 and 35. With the tubes 37 properly supported as, for example, by extending the ends of shafts 33 to a point beyond the axes of the tubes and providing a mounting member 64 at each of these points, these tubes will turn and will not tend to shift axially. With the turntable continuing to rotate, the bores of the tube will be successively connected with sources of vacuums. Thereafter they will be disconnected from such sources and vented to the outer atmosphere. As the turntable reaches a certain stage or point in its rotation, the rod 43 of each assembly will be disposed in line with a projectable rod 65' actuated, for example, by an air cylinder 66' and having at its upper end a contact member 67. If, by means of suitably timed automatically operating mechanism the rod 65' is at that moment projected, the rod 48 will be similarly projected to cause the apertured member 47 to move up-

wardly over the end of tube 37 and the attached mandrel 43. As will be hereinafter brought out, such a structure will function as an unloading mechanism. It is obvious that the structure of this mechanism might be modified in numerous manners or, in fact, entirely eliminated if manual unloading is resorted to. In the latter event, while a stripping mechanism would preferably be employed, it need not necessarily involve the rod 48 or other heretofore described details of structure. As will readily be understood, the mandrels 43 may be easily dismounted and replaced when this is necessary. When in mounted position, however, a proper seal will be established between them and the tubes 37. An automatic mechanism (not shown) may be employed to coat the mandrels or the barrel interiors with a suitable material to prevent mandrel oxidation and to lubricate the parts. This will be prior to the mounting of the syringe barrel thereon. Normally, however, it is preferred to coat the interiors of the barrels.

Various sources of heat may be employed to cooperate with the barrels mounted on the mandrels. In many respects it is preferred to employ a gas mixture directed toward the mandrels through suitably arranged burners. These burners may be arranged to cooperate to the best advantage with the mandrel-supported barrels. It is preferred to this end that the burners be stationary. In most instances separate tips will be employed, although slits for the passage of gas might be provided to define a zone of flame. Ordinarily a series of burners arranged around and adjacent the path of travel of the mandrels will be adequate; although, of course, burners might be disposed along an arc of lesser diameter than such path of travel. In certain instances one or more burners may travel a limited distance with a mandrel and return to an initial position where they cooperate with the barrel disposed upon a succeeding mandrel. In order to simplify the illustration, merely a single burner has been indicated by the numeral 65 in Fig. 2. Such illustration is therefore representative of the various sources of heat which might be employed and the arrangement of such sources.

Now considering the detailed structure of the syringe barrel to be operated upon by the machine and treated according to the teachings of the method, attention is directed to Fig. 6 in which a desirable unit of one type has been illustrated. As shown, this unit includes a barrel 68 formed of glass and presenting an open end defined by a flange or bead 69. The opposite end of the barrel is closed and provides a needle-mounting tip or portion 70 which is closed or sealed as indicated at 71. If desired, such sealing may be achieved by a separate element or substance rather than by portions integral with the barrel body. Units of this type are provided in any desired manner and embrace a bore which is materially larger than the finished piston-accommodating bore which is to be incorporated in their final structure. Each of the mandrels 43 is precisely formed to involve a diameter (when cool) slightly smaller than the diameter of the completed barrel.

Now turning to Fig. 9 in which a somewhat diagrammatic or schematic representation of the various steps of operation has been resorted to, attention is primarily directed to the upper right hand view. As will be understood from an examination of that portion of the drawing the barrel of the syringe has been disposed on the mandrel. Whether such disposition has occurred by automatic machinery or manually is immaterial. Prior to the disposition of the barrel upon the mandrel, the interior of the former is preferably coated with a suitable material to prevent oxidation. No air flow is, at this stage, occurring through the bore 45 of the mandrel. This will be because the pipe 53 extending from the assembly in question has its inner end in communication with one of the vented grooves 57. As indicated in the drawings, the loading and unloading stations may represent a travel or rotation on the part of the turntable amounting to approximately 22.5°. Conveniently a particular barrel will have an internal diameter substantially larger than the external diameter of the mandrel; the difference in diameters being at least .005". Due to the characteristics of glass, the localized heating of the flange zone of the barrel results in a decrease in diameter of the open end of the barrel. Therefore a sealing contact is established between the barrel and mandrel as indicated by the numeral 72 in Fig. 9. Substantially simultaneously with the establishment of the sealing contact between the barrel and mandrel, vacuum will begin to act through the bore of the latter. This will be because the pipe 53 connected to a certain mandrel bore which is traversing the flange-heating station will have been disconnected from the channel or groove 57 to which it has heretofore been connected and will have passed into operative connection with either the groove 59, 60 or 61.

As indicated in the drawings, this sealing stage may be continued throughout 67.5° of rotation of the turntable and involve a time period of 45 seconds. Due to the substantially plastic condition of the flange zone of the barrel and the vacuum existing within the same, the outer atmosphere pressing against the exterior face of the barrel will result in the maintenance of a proper intimacy of contact between that zone adjacent the open end of the same and the mandrel.

With suction through the mandrel bore into the interior of the barrel continuing, such barrel is progressively heated from a point adjacent the flange to a point adjacent its opposite end. Such heating may occur by any desired relative axial movement of the barrel and the mandrel with respect to a horizontal zone of heat defined, for example, by a series of burners. However it preferably occurs by arranging a series of burner nozzles in an inclined path as schematically indicated by the numeral 73. In any event, under continued rotation of the mandrel and barrel, the pre-heated parts of the latter are rendered successively substantally plastic from the flange to the tip ends. This results in the barrel being drawn into intimate contact with the mandrel surface as indicated by the numeral 74. The progressive heatings may continue through a 90° travel zone of the turntable and for a period of 60 seconds. At the end of that interval, and as shown in the drawings, the entire interior of the barrel will be in intimate contact with the mandrel and conform precisely to the exterior dimensions of the latter.

The co-efficient of expansion of glass is less than that of the metal from which the mandrel is formed. Therefore, even while the latter is somewhat protected from the action of the flame and general heat zone by the syringe barrel, it is to be understood that during pre-heating, flange shrinkage and progressive shrinkage, that the mandrel will have somewhat expanded. Such

expansion will, in no event, however, have resulted in the bore of the barrel being of too great a diameter. To this end, as afore brought out, the diameter of the mandrel, when cold, should be slightly smaller than the diameter of the piston to be used in conjunction therewith.

In the illustrated embodiment, nine mandrel assemblies are present. With equal spacing of these it is again apparent that they are separated 40° from each other. As previously stated, the length of the grooves or channels 59, 60 and 61 is preferably 118°. With three mandrel assemblies connected to these channels or grooves it is apparent that under these circumstances the inner end of a given duct or passage 54 of the plate 55 will ride beyond the end of one of these channels or grooves before the duct of the third following assembly is connected with the same groove. Therefore a condition will be presented under which at no time are two mandrel assemblies connected to the same groove. Consequently the full force of the vacuum may act on any assembly to assure the proper formation of the syringe barrel associated with the same. Also the successive assemblies being connected to different vacuum lines 23 and the parts coupled therewith, it follows that there will be no possibility of interference in the operation of one assembly by a different assembly during the critical periods of flange-sealing or barrel shrinkage.

After the shrinkage step the assembly is permitted to cool which also allows the barrel supported by the same to cool. Due to the different co-efficient of expansion of metal with respect to glass, it is apparent that during this cooling stage, the mandrel will shrink away from the inner surface of the barrel. This has been indicated at 75. The travel of the turntable during the cooling interval may be 135° and be maintained for an interval of 90 seconds. Thereafter the particular mandrel assembly will traverse the unloading station. At that time, either by automatic mechanism or otherwise the apertured member 47 may be elevated to strip the barrel from the mandrel. This completes the cycle of operation as performed by the machine. After the barrel is stripped from the mandrel, the sealed end portion 71 may be suitably detached from the syringe body by, for example, grounding it off. Thereafter, the tip 70 may be properly finished to present smooth surfaces. At the same time the flange portion 69 of the syringe may be subjected to finishing operations should this prove to be necessary or desirable. The barrel may now be annealed in order to relieve stresses. Also, after removal from the machine, the barrel may have applied to it suitable indicia such as graduation marks and numbers, trade and type marks, etc. etc. In any event, it will be found that by utilizing a proper plunger size, a syringe assembly has been formed by this method in which the clearance between the plunger or piston and the interior of the cylinder will be approximately .00005". Consequently, any one of a series of pistons of proper size may be employed with the barrel rather than merely an individual plunger or piston conformed precisely to the dimensions of only one barrel.

Thus, it is feasible by the practice of the present method and use of the machine to economically produce an all glass syringe assembly comprising a barrel and plunger and in which interchangeability will be possible between an entire series of these assemblies. Moreover, contrary to conventional construction in which the interior face of the barrel bore has a "satiny" finish incident to the lapping operations which have been resorted to, a barrel constructed in accordance with the present teachings will be clear. This will be a decided advantage, especially with regards to certain types of injections and medicaments. Of course if it is desired to incorporate in the syringe an exterior stained surface, stained scale, or screen process scale, this may be done at the time of the annealing step or otherwise as may prove most desirable.

Consequently a clear glass barrel is produced for use with a glass plunger. Obviously the glass employed to provide the barrel may be of any desired color, although it will ordinarily not be tinted. Due to the fact that the surface of the barrel is uninterrupted by the ordinary satiny finish resulting from the finishing operations, that surface is not subject to erosion. Moreover, clear liquids will be readily visible within the barrel and the scale and other indicia will appear in sharp contrast. The barrel will be uniform throughout the length traversed by the piston. Not being of large diameter adjacent its bottom or closed end, all medicament will be capable of being expelled from the interior of the barrel. Also no bubbles of air will remain trapped within the barrel with the piston fully projected. In the finished syringe barrel an uninterrupted skin surface will be presented. That skin surface being relatively quite hard, not alone is wear minimized, but breakage is reduced to a material extent. Where air bubbles have heretofore rendered tubing unsuitable for the formation of syringe barrels due to the danger of formation of "air lines" in the finished barrel, such tubing may, in many instances still be usable in connection with the present machine and method. This will be because the grinding and lapping operations, heretfore necessary to provide a finished syringe, will not be resorted to and consequently there will be no likelihood of the bore surface of the barrel being broken through to establish communication with these "air lines."

Thus, among others, the several objects of the invention as specifically aforenoted are achieved. Obviously numerous changes in construction of the barrel and rearrangement of the parts of the machine might be resorted to and the steps of the method might be varied in numerous particulars without departing from the spirit of the invention as defined by the claims.

I claim:

1. A syringe barrel forming machine comprising a mounting, a mandrel extending beyond said mounting, a surface forming a part of said mandrel adjacent its outer end and adjacent which the inner face of the end wall of a barrel may be disposed, a source of heat, means effecting relative movement between such source and said mandrel, said mandrel being formed with a bore extending through to said outer end surface of the mandrel, said mounting being formed with a communicating bore through which air may be exhausted and said mandrel outer surface being formed with a groove extending from its bore to the side face thereof.

2. A syringe barrel forming machine comprising a mounting, a mandrel extending beyond said mounting, a surface forming a part of said mandrel adjacent its outer end and adjacent which the inner face of the end wall of a barrel may be disposed, means for heating a barrel supported upon said mandrel, said heating means being movable outwardly with respect to said mandrel from a point in line with the surface of the same

adjacent which the inner edge of said barrel is disposed in an outward direction towards the opposite mandrel end and said mandrel being formed with an evacuating bore continuing as a groove across the outer mandrel surface.

3. In a syrfnge barrel forming machine in combination a rotatable support, an annular series of mandrels mounted upon said support, each of said mandrels being formed with an air-conducting bore, a pair of relatively rotatable plates disposed adjacent each other, connecting means between one of said plates and said support whereby these parts will move in synchronism, said machine being formed with passages extending one from each of said mandrel bores through to the face of one of said plates and with further passages each extending from a source of vacuum through to the adjacent face of the other plate, one of said plates being formed with arcuate grooves at different distances from its axis of rotation, the passages extending through to one plate being connected one to each of said grooves and passages extending through to the other plate terminating in end portions at different distances from the axis of said last-named plate and aligning with said grooves when said plates are disposed in operative relationship, said latter end portions being circumferentially spaced whereby as said support and the plate connected therewith rotate with respect to the second plate succeeding mandrels will have their individual bores solely and successively connected with different grooves throughout the arcuate distances of the latter.

4. In a syringe barrel forming machine in combination a rotatable support, an annular series of mandrels mounted upon said support, each of said mandrels being formed with an air-conducting bore, a pair of reltaively rotatable plates disposed adjacent each other, connecting means between one of said plates and said support whereby these parts will move in synchronism, said machine being formed with passages extending one from each of said mandrel bores through to the face of one of said plates and with further passages each extending from a source of vacuum through to the adjacent face of the other plate, one of said plates being formed with arcuate grooves at different distances from its axis of rotation, the passages extending through to one plate being connected one to each of said grooves and passages extending through to the other plate terminating in end portions at different distances from the axis of said last-named plate and aligning with said grooves when said plates are disposed in operative relationship, said latter end portions being circumferentially spaced whereby as said support and the plate connected therewith rotate with respect to the second plate succeeding mandrels will have their individual bores solely and successively connected with different grooves throughout the arcuate distances of the latter and one of said plates being formed with additional arcuately extending grooves connectable with the atmosphere whereby conditions of vacuum within said mandrel bores will be relieved.

5. In a syringe barrel forming machine in combination a rotatable support, an annular series of mandrels mounted upon said support, each of said mandrels being formed with an air-conducting bore, a pair of relatively rotatable plates disposed adjacent each other, connecting means between one of said plates and said support whereby these parts will move in synchronism, said

machine being formed with passages extending one from each of said mandrel bores through to the face of one of said plates and with further passages each extending from a source of vacuum through to the adjacent face of the other plate, one of said plates being formed with arcuate grooves at different distances from its axis of rotation, the passages extending through to one plate being connected one to each of said grooves and passages extending through to the other plate terminating in end portions at different distances from the axis of said last-named plate and aligning with said grooves when said plates are disposed in operative relationship, said latter end portions being circumferentially spaced whereby as said support and the plate connected therewith rotate with respect to the second plate succeeding mandrels will have their individual bores solely and successively connected with different grooves throughout the arcuate distances of the latter and means forming a part of said machine and functioning after the passages and the bores have completed their connection with said grooves to relieve conditions of vacuum within said bores and passages.

6. In a syringe barrel forming machine in combination a mandrel assembly including a lower mounting portion and a smooth, substantially uninterrupted preform-shaping body having an outer end, a support forming a part of said machine and connected to said portion to maintain said body in a position at which its outer end is uppermost, said outer end including a surface to lie adjacent the upper closed end of a cylindrical preform ensleeved over said body to support such preform in a position at which its lower end is disposed at a point short of and above said lower portion, said body being formed with a bore extending through to the lower portion of said assembly for direct connection with a source of vacuum associated with said machine and said body being formed with a passage extending outwardly from said bore through to its outer surface at a point in immediate proximity to the outer end of said body.

7. In a syringe barrel forming machine in combination a mandrel assembly including a lower mounting portion and a smooth, substantially uninterrupted preform-shaping body having an outer end, a support forming a part of said machine and connected to said portion to maintain said body in a position at which its outer end is uppermost, said outer end including a surface to lie adjacent the upper closed end of a cylindrical preform ensleeved over said body to support such preform in a position at which its lower end is disposed at a point short of and above said lower portion, said body being formed with a bore extending through to the lower portion of said assembly for direct connection with a source of vacuum associated with said machine, said body being formed with a passage extending outwardly from said bore through to its outer surface at a point in immediate proximity to the outer end of said body and the surface providing the outer mandrel end including relatively raised portions to act as spacing means to prevent sealing contact being established between such surface and the closed end of the preform.

8. A syringe barrel forming machine including in combination a turntable, means for rotating the same, a plurality of rotatable bored mandrels extending upwardly from said turntable to each receive a syringe preform having

a bored body provided with an open flanged lower end through which the mandrel extends upwardly into its bore, heating means disposed in operative relationship to the path of travel of a mandrel moved by said turntable to heat the lower end of the mandrel and the flange and adjacent body portion of a preform supported thereby to a degree such that said preform is rendered plastic and collapses into sealing contact with the adjacent mandrel surface, means connecting through the mandrel bore the space between the mandrel and the preform above the point of sealing contact with a source of vacuum, said heating means being disposed in operative relationship to the path of travel of the mandrel to heat the preform carried thereby between its flange and upper end whereby to cause atmospheric pressure to collapse said preform into intimate contact with said mandrel through the entire bore surface of such preform and said machine providing, during rotation of said turntable, a cooling zone through which said mandrel moves.

9. A syringe barrel forming machine including in combination a turntable, means for rotating the same, a plurality of rotatable bored mandrels extending upwardly from said turntable to each receive a syringe preform having a bored body provided with an open flanged lower end through which the mandrel extends upwardly into its bore, heating means disposed in operative relationship to the path of travel of a mandrel moved by said turntable to heat the lower end of the mandrel and the flange and adjacent body portion of a preform supported thereby to a degree such that said preform is rendered plastic and collapses into sealing contact with the adjacent mandrel surface, means connecting through the mandrel bore the space between the mandrel and the preform above the point of sealing contact with a source of vacuum, said heating means being disposed in operative relationship to the path of travel of the mandrel, means for causing a relative axially shifting of the latter and said heating means from a point adjacent the point of sealing contact towards the upper end of the mandrel whereby to cause atmospheric pressure to collapse said preform into intimate contact with said mandrel through the entire bore surface of such preform and said machine providing, during rotation of said turntable, a cooling zone through which said mandrel moves.

10. In a syringe barrel forming machine in combination a movable support, a series of mandrels mounted upon said support, each of said mandrels being formed with an air-conducting bore, a pair of relatively movable plates disposed adjacent each other, connecting means between one of said plates and said support whereby these parts will move in synchronism, said machine being formed with passages extending one from each of said mandrel bores through to the face of one of said plates and with further passages each extending from a source of vacuum through to the adjacent face of the other plate, one of said plates being formed with spaced grooves, the passages extending through to one plate being connected one to each of said grooves and passages extending through to the other plate terminating in end portions spaced from each other to an extent equal to the spacing of said grooves and aligning with the same when said plates are disposed in operative relationship, said latter end portions being longitudinally spaced whereby as said support and the plate connected therewith move with respect to the second plate succeeding mandrels will have their individual bores solely and successively connected with different grooves throughout the lengths of the latter.

11. In a syringe barrel forming machine in combination a movable support, a series of mandrels mounted upon said support, each of said mandrels being formed with an air-conducting bore, a pair of relatively movable plates disposed adjacent each other, connecting means between one of said plates and said support whereby these parts will move in synchronism, said machine being formed with passages extending one from each of said mandrel bores through to the face of one of said plates and with further passages each extending from a source of vacuum through to the adjacent face of the other plate, one of said plates being formed with spaced grooves, the passages extending through to one plate being connected one to each of said grooves and passages extending through to the other plate terminating in end portions spaced from each other to an extent equal to the spacing of said grooves and aligning with the same when said plates are disposed in operative relationship, said latter end portions being longitudinally spaced whereby as said support and the plate connected therewith move with respect to the second plate succeeding mandrels will have their individual bores solely and successively connected with different grooves throughout the lengths of the latter and one of said plates being formed with additional longitudinally extending grooves connectable with the atmosphere whereby conditions of vacuum within said mandrel bores will be relieved.

12. In a syringe barrel forming machine in combination a movable support, a series of mandrels mounted upon said support, each of said mandrels being formed with an air-conducting bore, a pair of relatively movable plates disposed adjacent each other, connecting means between one of said plates and said support whereby these parts will move in synchronism, said machine being formed with passages extending one from each of said mandrel bores through to the face of one of said plates and with further passages each extending from a source of vacuum through to the adjacent face of the other plate, one of said plates being formed with spaced grooves, the passages extending through to one plate being connected one to each of said grooves and passages extending through to the other plate terminating in end portions spaced from each other to an extent equal to the spacing of said grooves at different distances from the axis and aligning with the same when said plates are disposed in operative relationship, said latter end portions being longitudinally spaced whereby as said support and the plate connected therewith move with respect to the second plate succeeding mandrels will have their individual bores solely and successively connected with different grooves throughout the lengths of the latter and means forming a part of said machine and functioning after the passages and the bores have completed their connection with said grooves to relieve conditions of vacuum within said bores and passages.

13. In a syringe barrel forming machine in combination a mandrel assembly including an inner mounting portion and a smooth, substantially uninterrupted preform-shaping body having an outer end, a support forming a part of said mounting machine and connected to said portion to maintain said body in a position at which its

outer end is disposed outwardly of said mounting portion, said body end including a surface to lie adjacent the closed end of a cylindrical preform ensleeved over said body to support such preform in a position at which its opposite end is disposed at a point short of said mounting portion, said body being formed with a bore extending through to the inner portion of said assembly for direct connection with a source of vacuum associated with said machine and said body being formed with a passage extending outwardly from said bore through to its outer surface at a point in immediate proximity to the outer end of said body.

14. In a syringe barrel forming machine in combination a mandrel assembly including an inner mounting portion and a smooth, substantially uninterrupted preform-shaping body having an outer end, a support forming a part of said machine and connected to said portion to maintain said body in a position at which its end is disposed outwardly, said end including a surface to engage with the closed end of a cylindrical preform ensleeved over said body to support such preform in a position at which its opposite end is disposed at a point short of said mounting portion, said body being formed with a bore extending through to the inner portion of said assembly for direct connection with a source of vacuum associated with said machine, said body being formed with a passage extending outwardly from said bore through to its outer surface at a point in immediate proximity to the outer end of said body and the surface providing the outer mandrel end including relatively raised portions to act as spacing means to prevent sealing contact being established between such surface and the closed end of the preform.

15. A syringe barrel forming machine including in combination a turntable, means for rotating the same, a plurality of rotatable bored mandrels extending outwardly from said turntable to each receive a syringe preform having a bored body provided with an open flanged inner end through which the mandrel extends outwardly into its bore, heating means disposed in operative relationship to the path of travel of a mandrel moved by said turntable to heat the inner end of the mandrel and the flange and adjacent body portion of a preform supported thereby to a degree such that said preform is rendered plastic and collapses into sealing contact with the adjacent mandrel surface, means connecting through the mandrel bore the space between the mandrel and the preform beyond the point of sealing contact with a source of vacuum, said heating means being also disposed in operative relationship to the path of travel of the mandrel to heat the preform carried thereby between its flange and outer end whereby to cause atmospheric pressure to collapse said preform into intimate contact with said mandrel through the entire bore surface of such preform and said machine providing during continued rotation of said turntable, a cooling zone through which said mandrel moves.

16. A syringe barrel forming machine including in combination a movable support, means for shifting the same, a plurality of rotatable bored mandrels extending outwardly from said support, each of said mandrels comprising a cylindrical body and an outer end, said mandrels each receiving a syringe preform having a bored body provided with an open flanged inner end through which the mandrel extends outwardly into its bore, heating means disposed in operative relationship to the path of travel of a mandrel moved by said support to heat the inner end of the mandrel and the flange and adjacent body portion of a preform supported thereby to a degree such that said preform is rendered plastic and collapses into sealing contact with the adjacent mandrel surface, means connecting through the mandrel bore the space between the mandrel and the preform above the point of sealing contact with a source of vacuum, said heating means being also disposed in operative relationship to the path of travel of the mandrel, means for axially shifting said latter heating means from a point adjacent the point of sealing contact towards the upper end of the mandrel whereby to cause atmospheric pressure to collapse said preform into intimate contact with the face of the cylindrical mandrel body through the entire bore surface of such preform and said machine providing during continued rotation of said turntable, a cooling zone through which said mandrel moves.

17. A glass syringe barrel forming machine including in combination a movable supporting assembly, a plurality of mandrels mounted thereon and to each receive a glass preform to be shaped by conforming the surfaces thereof to the mandrel surfaces by the action of heat and atmospheric pressure, a fixed mounting for said assembly, a plurality of vacuum sources connected with said mounting, each of said mandrels being formed with passages, said assembly also including passages connected one to each of said mandrel passages, means for moving said assembly with respect to said mounting, means for successively coupling said assembly passages one to each of the vacuum sources as said assembly moves with respect to said mounting and means forming a part of said coupling whereby a given assembly passage is disconnected from one vacuum source prior to a succeeding passage thereof being connected therewith.

18. A method of forming a hypodermic syringe barrel which includes employing a tubular preform having a length substantially equal to that of the finished barrel, an open inner end and a bore of larger diameter than the exterior diameter of a cylindrical mandrel, introducing the outer end of the mandrel through the open inner end of the preform to ensleeve the latter upon said mandrel with its outer end adjacent the closed outer end of the preform and with an uninterrupted space free from all obstruction existing between the adjacent outer mandrel face and the bore face of the preform from its closed outer end to its inner end, heating the preform in a zone beginning with the edge defining its inner end to cause its bore to constrict into sealing contact with the mandrel in such zone, subjecting the space between the mandrel and preform bore to the action of vacuum, heating the preform in line with such space to render the preform plastic from such zone toward its outer end to cause atmospheric pressure to collapse the preform into intimate contact with the remainder of the mandrel face and thus impart to the bore a purely cylindrical configuration, cooling said preform and mandrel to cause the latter to shrink out of contact with the bore surface and sliding the barrel—resulting from the steps to which said preform has been subjected—in an outward direction over said mandrel to remove it therefrom.

19. A method of forming a hypodermic syringe barrel which includes employing a tubular pre-

form having a length substantially equal to that of the finished barrel, an open inner end and a bore of larger diameter than the exterior diameter of a cylindrical mandrel, arranging said mandrel to extend in a direction upward from the horizontal, introducing its upper end through the open inner end of the preform to ensleeve the latter upon said mandrel with its outer end adjacent the closed outer end of the preform and with an uninterrupted space, free from all obstruction, existing between the adjacent outer mandrel face and the bore face of the preform from its closed outer end to its inner end, subjecting the preform to a preheating action and thereupon heating said preform in a zone beginning with the edge defining its inner end to cause its bore to constrict into sealing contact with the mandrel in such zone, thereupon subjecting the space between the mandrel and preform bore to the action of vacuum, heating the preform beginning at a point adjacent its zone of sealing contact in an upward direction to render that preform plastic from the zone of seal toward its upper end to cause atmospheric pressure to collapse the preform into intimate contact with the remainder of the mandrel face and thus impart to the bore a purely cylindrical configuration, cooling said preform and mandrel to cause the latter to shrink out of contact with the bore surface and sliding the barrel—resulting from the steps to which said preform has been subjected—in an upward direction over said mandrel to remove it therefrom.

20. A syringe barrel forming machine including in combination a movable support, means for moving the same, a plurality of rotatable bored mandrels extending outwardly from said support to each receive a syringe preform having a bored body provided with an open inner end through which the mandrel extends outwardly into its bore, heating means including means disposed adjacent said support for preheating a preform supported by a mandrel, said heating means also including further means disposed in operative relationship to the path of travel of a mandrel moved by said support to heat the inner end of the mandrel and adjacent body portion of a preform supported thereby to a degree such that said preform is rendered plastic and collapses into sealing contact with the adjacent mandrel surface, means connecting through the mandrel bore the space between the mandrel and the preform beyond the point of sealing contact with a source of vacuum, means for causing relative movement in an axial direction between said heating means and mandrel to heat the preform carried thereby between its inner and outer ends whereby to cause atmospheric pressure to collapse said preform into intimate contact with said mandrel through the entire bore surface of such preform and said machine providing during continued movement of said support, a cooling zone through which said mandrel moves.

21. A glass syringe barrel forming machine including in combination a movable supporting assembly, a plurality of mandrels mounted thereon and to each receive a glass preform to be shaped by conforming the surfaces thereof to the mandrel surfaces by the action of heat and atmospheric pressure, a fixed mounting for said assembly, a plurality of vacuum sources connected with said mounting, each of said mandrels being formed with passages, said assembly also including passages connected one to each of said mandrel passages, means for moving said assembly with respect to said mounting, means for successively coupling said assembly passages one to each of the vacuum sources as said assembly moves with respect to said mounting, means forming a part of said coupling whereby a given assembly passage is disconnected from one vacuum source prior to a succeeding passage thereof being connected therewith, heating means disposed adjacent the point at which coupling occurs to heat the inner ends of preforms received by mandrels to shrink the preforms into sealing contact with said mandrels adjacent the inner ends of the preforms and operating means to cause said heating means to function during the coupling of said assembly passages to the vacuum sources to heat and render plastic the balance of a preform body and cause it to conform to the mandrel.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,301,714	Kueppers	Apr. 22, 1919
1,999,525	Morscholz	Apr. 30, 1935
2,363,170	Smith	Jan. 30, 1945
2,392,104	Smith	Jan. 1, 1946
2,403,073	Geiger et al.	July 2, 1946
2,423,113	Pfleghar	July 1, 1947
2,490,252	Brewer	Dec. 6, 1949
2,531,394	Campbell	Nov. 28, 1950

FOREIGN PATENTS

Number	Country	Date
497,486	Great Britain	Dec. 19, 1938