No. 793,797. PATENTED JULY 4, 1905.

D. MURRAY.

APPARATUS FOR FORMING GLASS.

APPLICATION FILED FEB. 16, 1903.

3 SHEETS—SHEET 1.

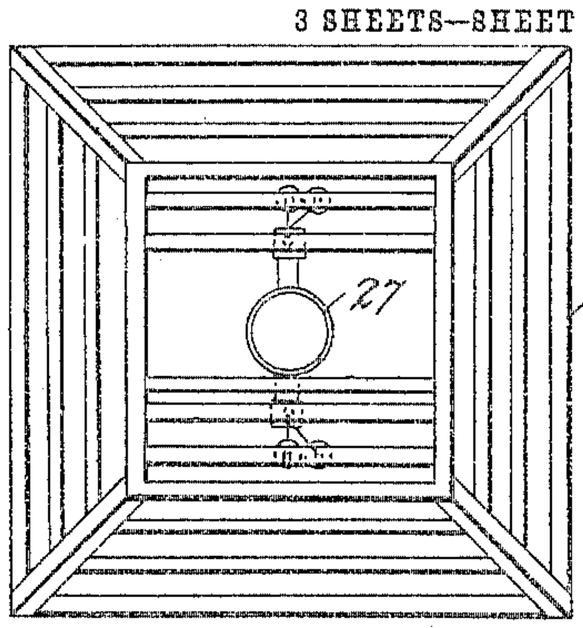

Fig. 2

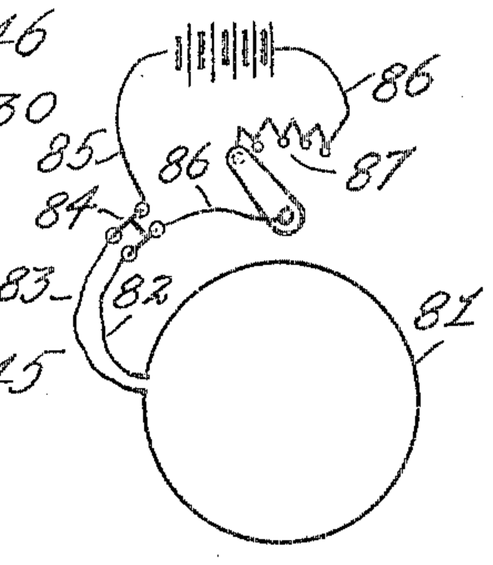

Fig. 2A

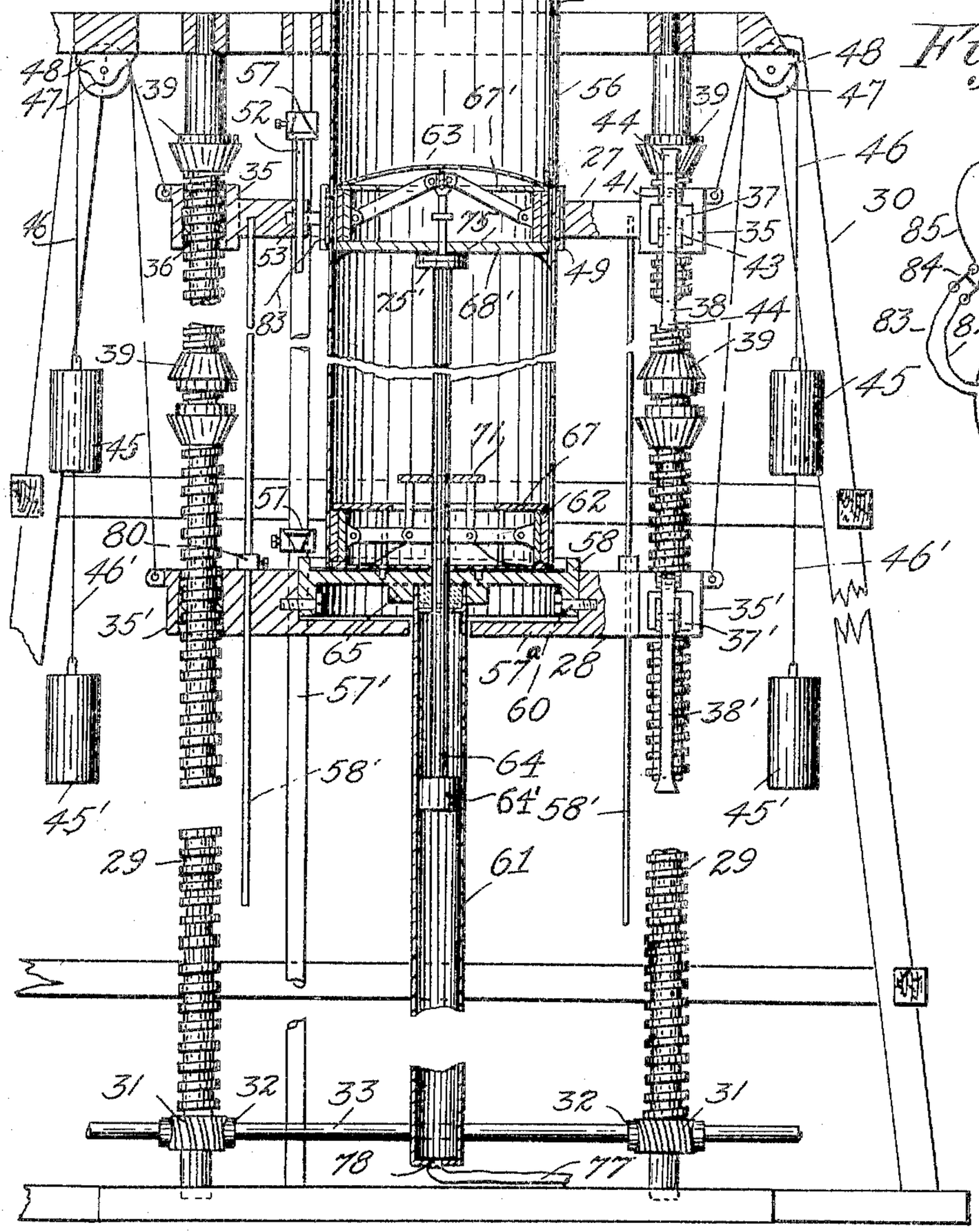

Fig. 1

WITNESSES:

Raymond C. Spaulding

Calista Adams

INVENTOR.

Daniel Murray

BY Frank E. Adams.

ATTORNEY.

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D. MURRAY.

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3 SHEETS—SHEET 2.

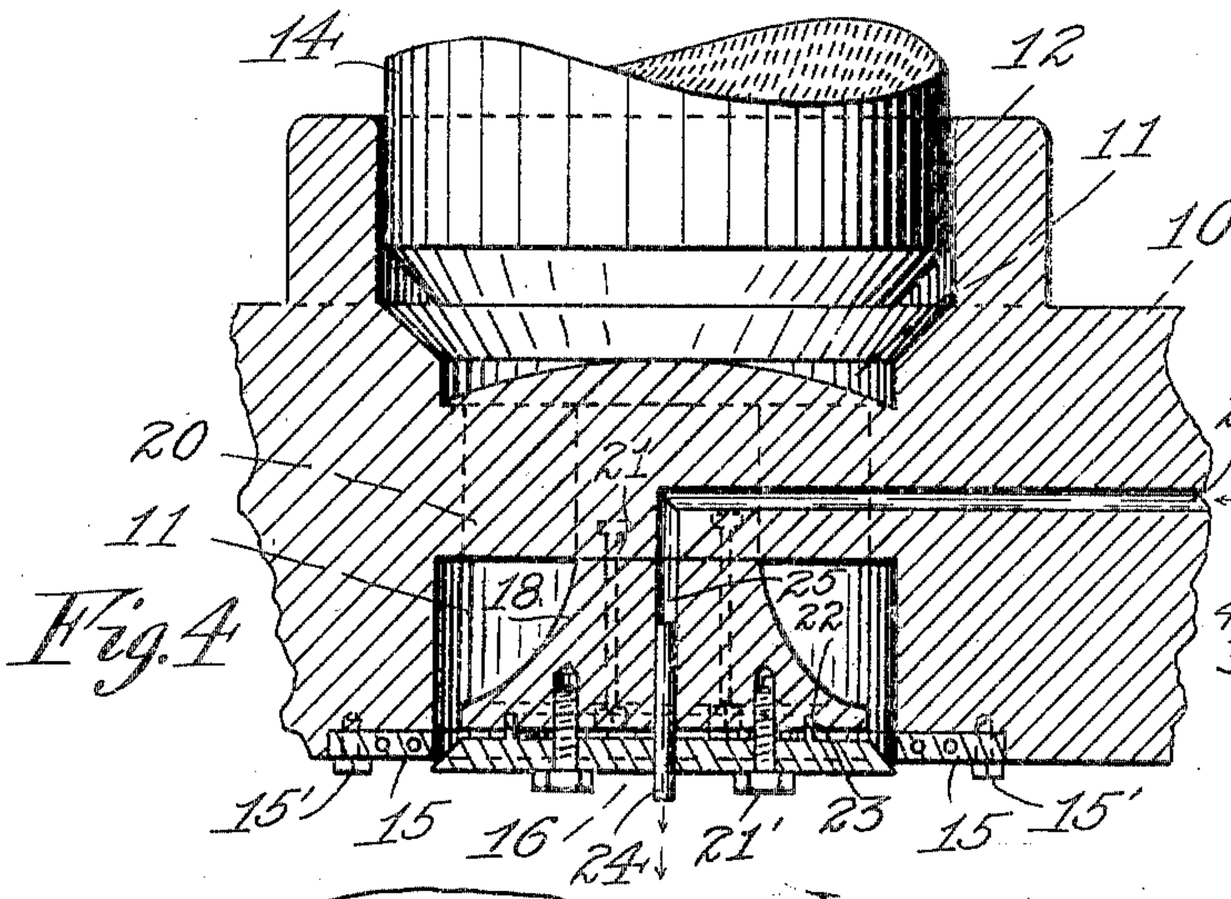

Fig. 4

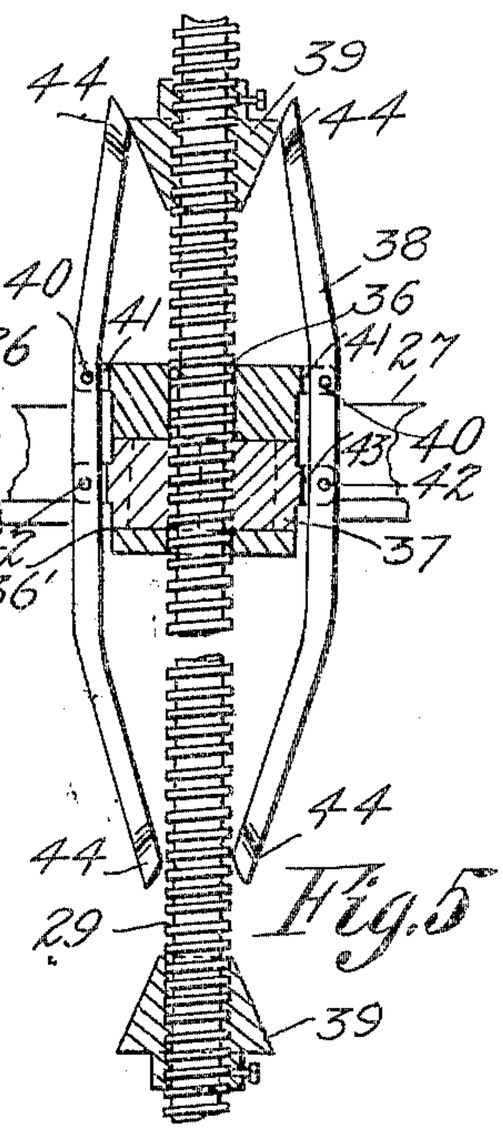

Fig. 5

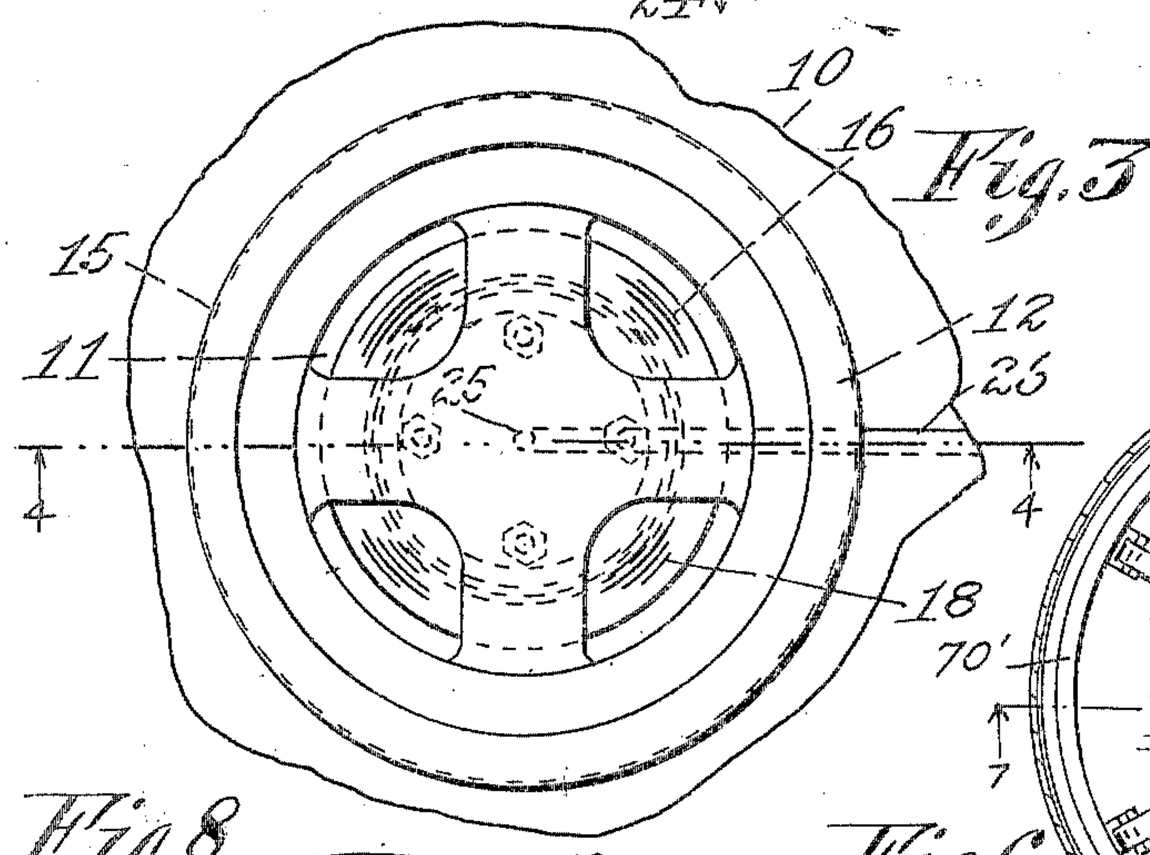

Fig. 3

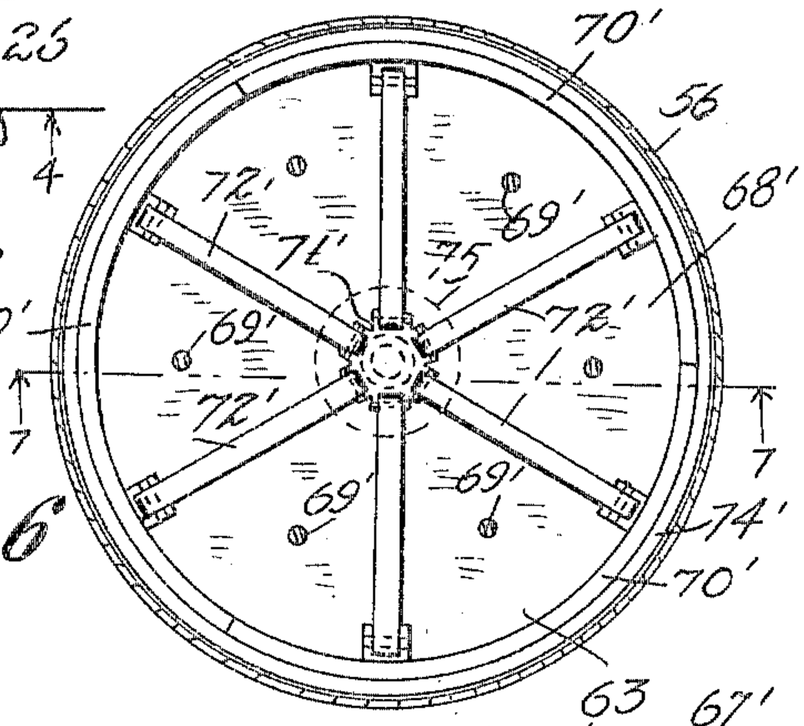

Fig. 6

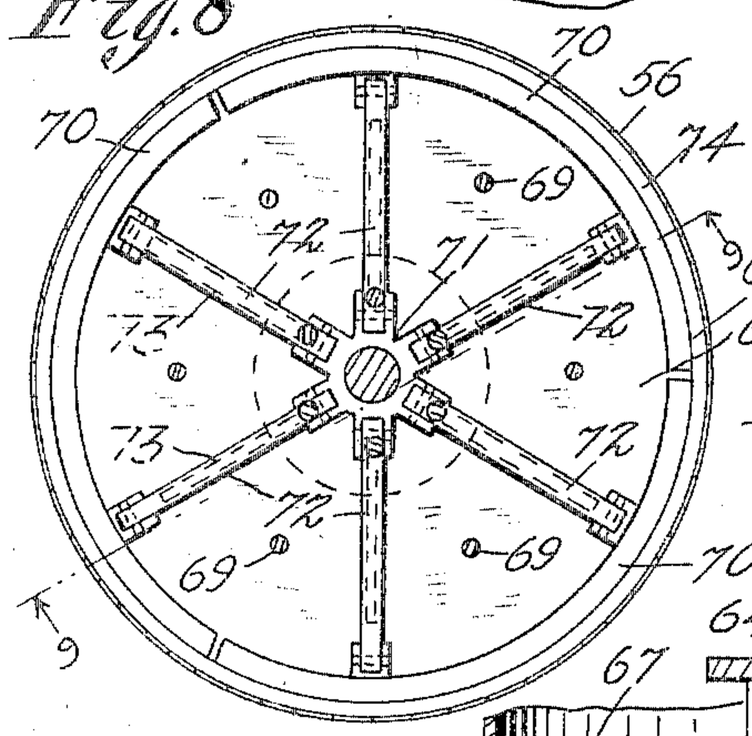

Fig. 8

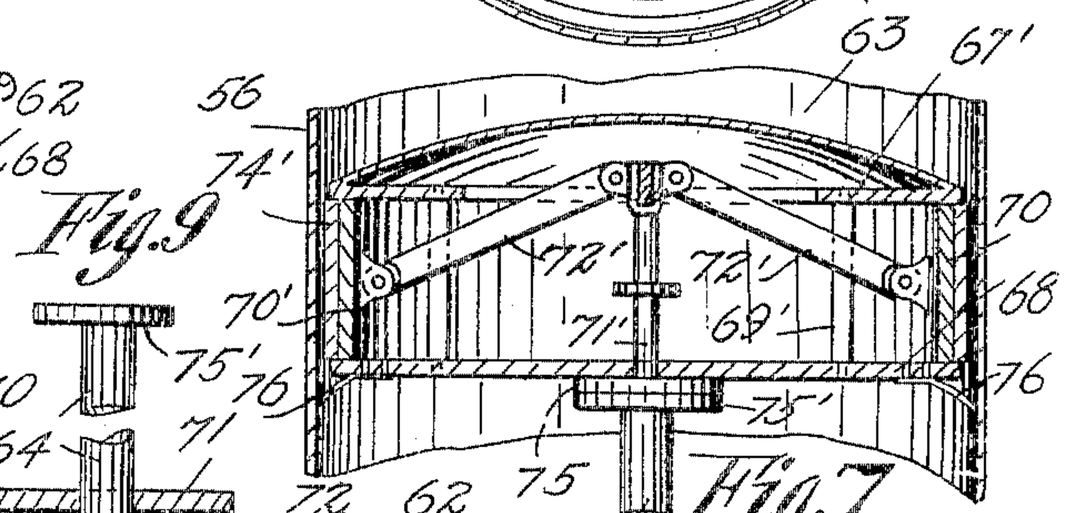

Fig. 7

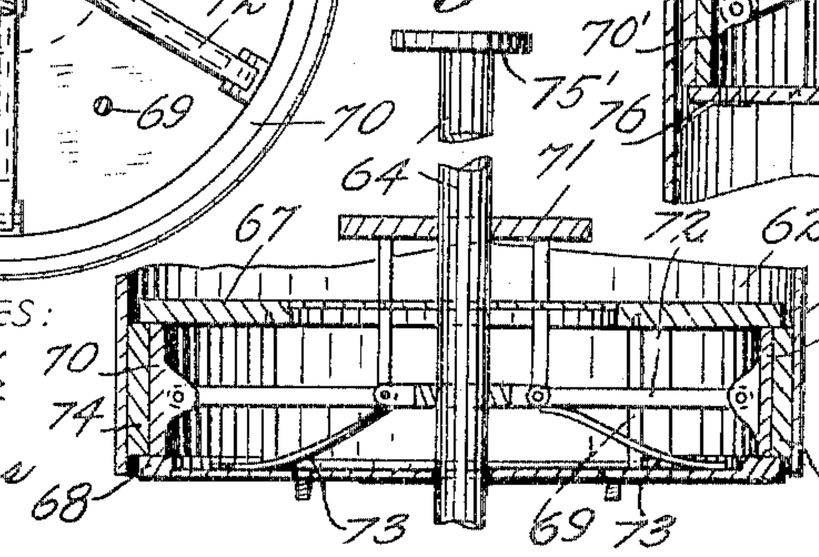

Fig. 9

WITNESSES:

Raymond C. Spaulding

Julia C. Adams

INVENTOR.

Daniel Murray

BY Frank E. Adams

ATTORNEY.

No. 793,797. PATENTED JULY 4, 1905.

D. MURRAY.

APPARATUS FOR FORMING GLASS.

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3 SHEETS—SHEET 3.

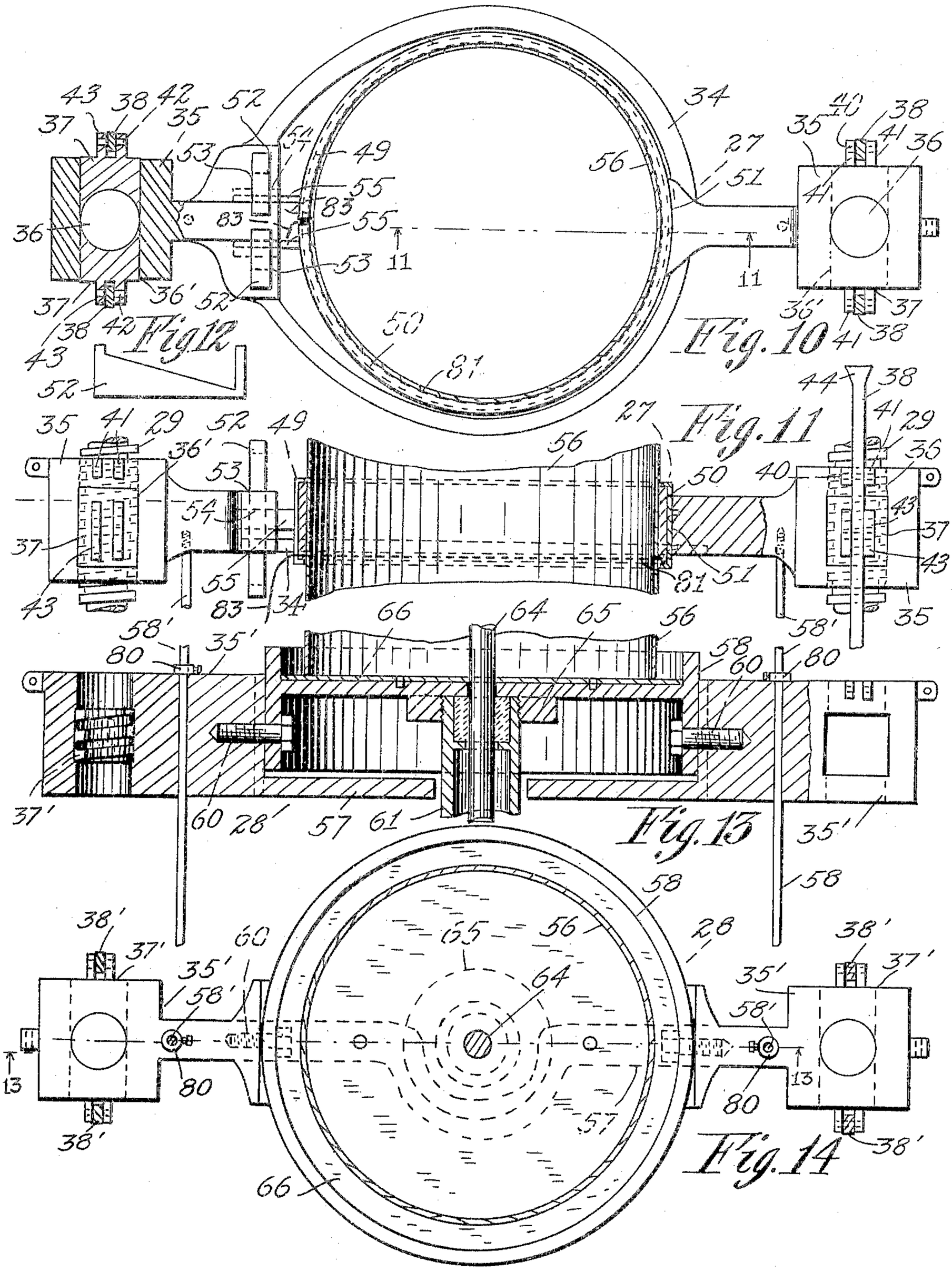

Fig. 12

Fig. 10

Fig. 11

Fig. 13

Fig. 14

WITNESSES:

Raymond C. Spaulding
Arlita Adams

INVENTOR.

Daniel Murray

BY Frank E. Adams

ATTORNEY.

No. 793,797. Patented July 4, 1905.

UNITED STATES PATENT OFFICE.

DANIEL MURRAY, OF SEATTLE, WASHINGTON.

APPARATUS FOR FORMING GLASS.

SPECIFICATION forming part of Letters Patent No. 793,797, dated July 4, 1905.

Application filed February 16, 1903. Serial No. 143,712.

To all whom it may concern:

Be it known that I, DANIEL MURRAY, a citizen of the United States of America, and a resident of Seattle, in the county of King and State of Washington, have invented certain new and useful Improvements in Apparatus for Forming Glass, of which the following is a specification.

My invention relates to improvements in apparatus for forming glass, and has special reference to a device of this class which is especially adapted to produce articles from molten glass.

Among numerous objects attained by this invention and readily understood from the following specifications and accompanying drawings, included as a part thereof, is the production of a simple and inexpensive apparatus for producing a continuously-forming glass article and which embodies essential features of adaptability, utility, and general efficiency which render the apparatus economical of the molten glass, easy of operation and of great capacity, and reduces the cost of producing glassware.

The above-mentioned and numerous other objects equally as desirable are attained by the constructions, combinations, and arrangements of parts as disclosed on the drawings, set forth in this specification, and succinctly pointed out in the appended claims.

With reference to the drawings filed herewith, and bearing like reference characters for corresponding parts throughout, Figure 1 is a view in side elevation of my improved apparatus disclosed with a glass tube in relative position as formed thereby and shows a majority of the parts of the apparatus in vertical section and portions of the frame, guides, and other parts broken away to reduce the view in height. Fig. 2 is a view in plan of the main frame of the appliance, shown on small scale. Fig. 2^{A} is a diagram including the electrical glass-severing device, which is shown removed from the appliance. Fig. 3 is a plan view of a portion of the bottom of the tank or receptacle for the molten glass, indicating the aperture adapted for the feeding out of the molten glass by gravity and indicates the mold in relative position at the mouth of the feed-aperture. Fig. 4 is a view in vertical section of said portion of the tank or receptacle, taken on line 4 4 of Fig. 3 and viewed as the arrows indicate. Fig. 5 is a view in side elevation of a portion of one of the screw-threaded carrier-guides and indicates the guide-lug of the upper carrier engaged therewith and shown in vertical section to disclose one of the nut parts adapted to operatively connect the carrier with the guide and also indicates the levers and cams employed to open and close the nuts. Fig. 6 is a view in plan of the upper tube-entering plug with the cap removed and a glass tube in relative position and horizontal section and shows the parts in relative position when the plug stands collapsed. Fig. 7 is a view of said plug with the cap restored and indicated in vertical transverse section taken on line 7 7 of Fig. 6 viewed as the arrows indicate and shows a portion of a glass tube in relative position and like section. Fig. 8 is a plan view of the lower plug with the upper head removed and a glass tube in relative position and in horizontal section and the parts in relative position when the plug stands expanded. Fig. 9 is a view of said plug with the upper head restored and indicated in vertical transverse section on line 9 9 of Fig. 8 looking as the arrows indicate and shows a portion of a glass tube in relative position and like section. Fig. 10 is a view in plan of the upper carrier, showing one of the guide-lugs in horizontal section and the nut-operating levers on the opposite guide-lug in like section and indicates a portion of a glass tube clamped in the carrier and shown in horizontal section. Fig. 11 is a view in side elevation of said carrier with a glass tube in relative position and shows the center portion of the carrier in partial section on line 11 11 of Fig. 10 and indicated with portions of the guide-rods engaged with the carrier and the nut-operating levers at one side removed. Fig. 12 is a side view of one of the wedges employed to close the clamp which is on the upper carrier. Fig. 13 is a view of the lower carrier shown in vertical section, taken on line 13 13 of Fig. 14 viewed as the arrows indicate and indicated with one of the guide-

lugs in exterior view with the nut parts removed therefrom and the lower end of a glass tube in relative position and like section; and Fig. 14 is a view in plan of the lower carrier with the nut-operating levers in horizontal section and a glass tube in relative position and like section.

This invention comprehends apparatus for producing a continuously-forming article from a supply of molten glass and includes means whereby a continuous flow of molten glass is transformed into a continuously-forming article, means by which molten glass is constantly presented to the transforming means, and means to carry the article formed.

The molten glass is conveniently given the desired conformation by passage through a suitable mold, and said glass is presented to the mold by allowing it to pass by gravity in a continuous flow from a suitably-maintained supply and the glass article handled by means of movably-mounted carriers.

The apparatus employed to produce a glass article in the above manner includes a suitably-elevated receptacle, as a pot or tank 10, which is composed of refractory material and adapted as means in which a supply of molten glass can be conveniently maintained. This receptacle comprises the melting-tank of an ordinary glass-furnace of any desired form and is provided at a convenient point with an aperture, as 11, formed in the body of the receptacle at a suitable place to allow molten metal to pass or feed therefrom by gravity. This feed-aperture in the present instance is preferably located in the bottom wall of the tank, and about this aperture an upwardly-extending continuous ridge, as 12, is formed on the bottom of the receptacle to prevent foreign sediment from passing from the tank with the flow. The upper edge of this opening is suitably shaped to act as the seat for a removable plug 14, by which the flow of metal can be shut off when desired, and about the outer edge of the opening suitable means, as a molding-ring 15, is provided to give the desired shape to the exterior surface of the flowing molten metal as it clears the feed-aperture. This ring comprises an annulus having suitable annular channels in the body adjacent the bore, in which water is circulated in any desired or well-known manner to conveniently keep the ring cool, and thereby expediate the cooling of the molten metal in the flow as it passes through the ring, and thereby promote the stiffening of the metal, and this ring is removably secured in place by suitable bolts, as 15′, or the like, which are passed through suitable apertures provided in the body of the ring and engaged in corresponding screw-threaded holes in the body of the tank or receptacle, so that the ring can be conveniently replaced by one having a bore of different diameter or form. The wall of the bore in this ring is shaped in conformity with the form and size desired for the exterior of the article to be formed from the molten glass in the receptacle.

In the present embodiment a suitable device is provided at or adjacent the mouth of the feed-aperture 11 to pierce or penetrate the flow of molten glass, and this device comprises a suitable spreader, as 16, Figs. 1, 3, and 4, which is supported in the path of movement of the flow concentric with the bore of molding-ring 15 and serves to direct the molten metal for discharge around its entire margin, and thereby cause the metal to assume a hollow form as it passes therefrom. This spreader comprises a detachable body of substantially conical form, whose diameter at the base edge is substantially equal to that of the bore of said molding-ring, and this spreader is composed of a top frustum 18 and a detachable base frustum 19, the former of which is preferably secured to the hub of a suitable spider 20, adapted to support the same and which is conveniently supported in the feed-aperture 11 at a suitable point to cause the base edge of the spreader to normally lie just beyond the outer edge of the bore of the molding-ring. This spider is preferably formed integral with the body of the tank or receptacle 10, and the spreader is conveniently secured thereto by vertically-disposed bolts, as 21, Fig. 4, which are anchored in the hub of the spider and pass through apertures formed in the top frustum of the spreader, and the base frustum of the spreader is conveniently, removably, and adjustably connected to the top section or frustum by suitable vertically-disposed cap-bolts, as 21′, which pass through suitable apertures in the base and have screw-threaded engagement in the top section, so that a base of different size or form can be substituted to form an article of a different size or shape and the attached base raised or lowered relatively to the molding-ring 15 by turning said bolts in the proper direction to regulate the size of the annular opening, and thereby the volume of the flow.

The base frustum 19 comprises a circular disk formed with an annular upwardly-projecting flange 22 of less diameter than the disk, which fits snugly but slidably in a suitable annular groove 23, formed in the bottom of the top section, and serves as a packing-ring to prevent the molten metal from spreading between said sections, and a suitable centrally-located aperture is conveniently formed in this disk to receive a suitable blowpipe, as 24, which projects downwardly with the tip below the spreader and extends upwardly into a suitable channel, as 25, arranged in the top section, and this channel lies in communication with a suitable duct, as 26, conveniently formed in the body of the spider 20 and which extends to the outside of the body of the receptacle 10, so that compressed air or the like can be conveniently passed to the blowpipe

by connecting said duct to a source of supply through the medium of suitable piping or the like. (Not shown.) As now considered this channel is annular and serves to transform the flow into a tubular article, and by conveniently presenting molten glass for passage through this mold in a continuous flow a continuously-forming tube is produced, and by introducing compressed air in the tube it is conveniently held in perfect form until the metal in the body becomes fully hardened.

By employing a receptacle with an aperture for discharge, as heretofore described, a volume of molten glass is constantly presented for formation, and by introducing an inflating agent, as compressed air or the like, into the flow from said aperture a continuously-forming hollow article is produced, and by the application of the mold at the mouth of the feed-aperture a positive predetermined shape or form is given to the flow. Thus by the application of a proper appliance to handle the product after it passes from the mold a continuously-forming tube of glass is obtainable, and sections of this tube can be severed from the lower end successively, so that the formation of the tube may continue uninterrupted after the apparatus is once started.

The appliance comprehended in this invention to handle the glass after it passes the transforming means includes an upper carrier and a lower carrier, which are each suitably mounted for reciprocal movement and are each arranged for independent travel. These carriers are marked, respectively, 27 and 28 on the drawings, and they are suitably slidably supported one above the other on vertically-disposed guides, as 29, which preferably comprise screw-threaded rods rotatably mounted in any convenient manner in a main frame 30 of any desired form or construction adapted to support the several parts of the appliance. These guides are separated the required distance to receive the carriers therebetween and are given simultaneous rotation by any suitable means, as by worm-wheels 31, one of which is fixedly mounted on each guide at the lower end, and worms 32, meshing with said wheels and secured on a rotatably-mounted drive-shaft, as 33, which is driven in any suitable manner, as by a belt and clutch-pulley (not shown) adapted to transmit power from an engine, electric motor, or the like.

The body of carrier 27 includes an annular center portion or ring 34, whose bore is of suitable diameter to receive freely the glass tubing, as 56, from the transforming device, and this ring is provided with laterally-projecting lugs 35, which are secured thereto at diametrically opposite points and are each formed with a vertically-disposed aperture or guideway 36 of suitable size to slide with a good fit upon the respective guide-rod 29. The walls of these guideways are preferably formed with horizontally-disposed squared apertures 36′, arranged at diametrically opposite points and each forming the seats for nut parts, as 37, of a suitable split nut, which parts slide in said seats and have screw-threads on their inner ends arranged to fit the screw-threads on the guide-rods 29, so that when these nut parts are closed upon the rods the threads thereon engage with threads upon the rods, and the carrier can then be readily raised or lowered by turning said rods in the proper direction. These nut parts are preferably opened and closed automatically by means of respective vertically-disposed levers, as 38, and cams 39, Fig. 5, the former of which are conveniently fulcrumed substantially midway their length on suitable pivots 40, mounted on the guide-lugs 35 by securing them in suitable apertures, formed in laterally-projecting ears 41, arranged on the lug above each nut, and these levers are engaged with respective nut parts by means of suitable pivots 42, which are secured in transversely-disposed apertures, formed in said levers and engaged in corresponding apertures provided in suitable ears 43, formed on the outer ends of the nuts. These levers are preferably formed with both end portions bent inwardly at a slight angle, so that the bodies of the levers will lie clear of the cams, if the ends of the levers should pass therebeyond, and these end portions of the levers are spread or broadened slightly at the free extremities to form suitable wipers, as 44, which are adapted to engage the cams 39, arranged in the path of movement of said wipers at each end of the travel of the carrier. The cams 39 each comprise a conical frustum, threaded to fit the guide-rods 29, and a suitable set-screw is arranged in a screw-threaded aperture in the hub of the cam, by which the cam is conveniently adjustably secured in position on the guide. These cams are suitably disposed on the guides, so that the wipers on the ends of levers 38 will ride up the inclined surfaces of the cams, so that the nuts will be fully opened as the carrier reaches the lowest point of its travel and closed as it reaches the highest point.

In the present instance the guide-rods are rotated continuously in the proper direction to drive the carrier downwardly when the split nuts are engaged therewith, and the carrier is conveniently returned or raised when the nuts are disengaged from the guides by means of suitable counterbalances or weights 45, which are connected by flexible ropes or chains, as 46, to the guide-lugs of the carrier and these ropes or chains are passed over suitable guide-pulleys 47, rotatably mounted at the top of the main frame in brackets, as 48, which are arranged in suitable position to give the ropes or chains free action on the pulleys as the carrier is reciprocated on the guides.

Upon the carrier 27 is mounted a suitable clamp 49, preferably consisting of a divided

annulus, having a bore substantially equal in diameter to the exterior diameter of the article produced by the transforming means, and is composed of resilient metal constructed so that the clamp will be normally yieldingly held open or expanded by the resiliency of the metal from which it is made. This clamp has considerable width of face and is formed with a continuous broad channel in the wall of the bore, adapted to receive a facing, as 50, composed of suitable soft material, as felt or the like, and the clamp is conveniently secured to the carrier, with the free ends lying adjacent the base or inner end of one of the guide-lugs, by fastening the body of the clamp upon a vertically-disposed shoulder, as 51, conveniently formed at the base of the opposite guide-lug. The base of the clamp is conveniently closed automatically by means of suitable vertically-disposed wedges, as 52, which are operatively mounted on that guide-lug of the carrier which lies adjacent the free ends of the clamp in oppositely-disposed seats comprising suitable vertically-disposed apertures 53, arranged in said guide-lug at opposite sides of the longitudinal center line thereof. These wedges are arranged to embrace laterally-projecting tongues 55, which are secured to each end of the clamp and project into suitable horizontally-disposed slots, as 54, formed in the base of the guide-lug, so as to intersect the seats of the wedges, said slots being of suitable width to allow the tongues to move laterally as the clamp-springs open when the wedges are raised in their seats. These wedges are operated by means of suitable strike-lugs 57, which are suitably supported in the path of movement of the wedges at each end of the travel of the carrier by securing them to a suitably vertically disposed rod 57′, conveniently fixed in the main frame 30 of the appliance. These strike-lugs are preferably formed with suitable hubs bored to slidably fit the rod 57′ and have suitable set-screws arranged in screw-threaded apertures in the wall of the bore, by which the lugs can be conveniently adjustably secured in suitable positions on the rod. These lugs are disposed at each end of the travel of the carrier, so that the wedges will be forced into their seats, and thereby made to close the clamp about the glass tube 56 from the mold as the carrier reaches the upper end of its travel, and as the carrier approaches the lower end of its travel the opposite strike-lug will force the wedges from their seats and allow the clamp to spring open and release the glass tube at the same time that the split nuts are disengaged from the guide-rods to free the carrier for its return by action of the counterbalances 45.

The lower carrier 28 is formed with a horizontally-disposed cross-bar, as 57ª, at the ends of which are secured suitable guide-lugs 35′, which are constructed substantially the same as the guide-lugs on the upper carrier, and nut parts 37′ are operatively mounted on these lugs in a manner similar to the nuts on the upper carrier, and levers 38′ are operatively connected to said nuts, so that they may be operated manually, if desired. Upon this portion of the lower carrier a suitable horizontally-disposed platform, as 58, preferably of circular form, is conveniently mounted, and this platform is made somewhat greater in diameter than the glass body or tube which issues from the bottomless mold, and it is preferably movably mounted on the body of the carrier so that it can be tipped or tilted to expedite the removal from the appliance of sections of the glass body which are severed from its lower end. This platform is conveniently mounted for tilting by means of suitable oppositely-disposed trunnions, as 60, consisting of horizontally-disposed cap-bolts, which are fitted loosely in suitable apertures provided in the side of the platform and are secured in the base or inner ends of respective guide-lugs 35′ above the cross-bar 57ª, and the center portion of this bar 57ª is preferably offset laterally to clear a downwardly-extending cylinder, as 61, which is secured to said platform and is employed in operating the expandible plugs, as 62 and 63, adapted to seal the glass tube in a manner hereinafter set forth. This lower carrier is raised in a manner similar to that heretofore described for raising the upper carrier, as by means of counterbalances or weights 45′, which are connected thereto by flexible ropes 46′, which pass over suitable guide-pulleys and are fastened to the guide-lugs of the lower carrier. The platform of the lower carrier is preferably formed with a centrally-located aperture through which an upwardly-extending piston-rod 64 operates, and about this aperture, on the under surface of the platform, is provided an annular flange 65, having internal screw-threads adapted for the connection to the cylinder 61, which is formed with corresponding screw-threads on the upper extremity, and a suitable stuffing-box is arranged at this end of the cylinder in which packing is placed about the piston-rod. Upon the upper surface of the platform is placed a suitable cushion 66, adapted to shield the edge of the glass tube from contact with the platform, and preferably consisting of a section of felt or the like, and upon this platform is secured an expandible plug 62, which is adapted to hermetically seal the lower end of the glass tube 56. This plug preferably comprises an upper and a lower head of less diameter than the bore of the glass tube and marked 67 and 68, respectively, and these heads are secured at the desired distance apart by suitable distance-rods or the like, as 69, and the perimeter of the plug is preferably composed of abutting semicircular sections, as 70, which fit snugly but movably between said heads and are op-

eratively connected to a vertically-movable cross-head 71, slidably mounted on piston-rod 64 by means of radially-disposed links 72, which are conveniently pivotally connected to said head and to respective sections of the perimeter. These sections of the perimeter are normally yieldingly held in expanded position by suitable springs 73, which are seated on the lower head of the plug and press upwardly on the cross-head, so as to normally hold said links in a substantially horizontal position. About the perimeter of the plug is placed an annular packing-band, as 74, which is composed of suitable elastic material, as rubber or the like, and this band is of suitable width to fit snugly but movably between the heads of the plug, so that when the perimeter of the plug is expanded this band will be stretched and pressed against the inner surface of the glass tube, and when the perimeter is collapsed the band will contract and free itself from contact with the glass tube.

The upper plug 63 is preferably composed of oppositely-disposed heads, as 67′ and 68′, which are slightly less in diameter than the diameter of spreader 16 and are secured together at the desired distance apart by distance-rods, as 69′, and the perimeter of the plug is composed of abutting semicircular sections 70′, which fit snugly but movably between said heads and are operatively connected to a gravity-head 71′ by radially-disposed links 72′, which are suitably pivoted to said head and to respective sections of the perimeter. This gravity-head is of suitable weight to normally yieldingly hold the perimeter of the plug in expanded position and is formed with a downwardly-extending stem which projects below the lower head of the plug and is preferably formed with a disk or flange, as 75, at the lower end, which is adapted to contact a flange 75′ of similar size, fixedly mounted on the upper end of piston-rod 64, whereby the plug can be readily collapsed and raised by an upward movement of said rod, which first serves to raise the gravity-head and then lift the plug as it is moved upwardly. About the perimeter of this upper plug is placed an annular packing-band 74′, composed of elastic material, as rubber or the like, of suitable width to fit snugly but movably between the heads of the plug, so that it will be free to stretch as the perimeter of the plug is expanded and to contract when the plug is collapsed. Suitable spring-catches, as 76, each preferably comprising a short section of suitable resilient material secured by one end to the bottom head of the plug with the free end projecting slightly beyond the periphery of the packing-band, are provided to contact the inner surface of the glass tube, and thereby prevent the plug from falling when the piston-rod is withdrawn from the gravity-head to permit said head to drop, and thereby expand the plug.

The cylinder 61 is of suitable length to allow the piston-rod 64 to move upwardly the distance required to raise the upper plug just above the upper end of the travel of the upper carrier when the lower carrier is at its lowest point of travel and to allow the rod to move downwardly the distance required to bring the flange thereon against the cross-head of the lower plug, so that it will be thus made to act to collapse said plug, and a suitable piston 64′ is fixedly mounted on the lower end of said rod and operatively fitted in said cylinder. A suitable port, as 48, is arranged in the lower end of the cylinder for the ingress and egress of suitable fluid, as compressed air, which is conveyed thereto from a suitable source of supply through a flexible conduit, as 77, attached to the cylinder at said port and also adapted for the exhaust of the fluid.

The carrier 27 is conveniently made to drive the carrier 28 downwardly correlatively to its own descent by means of vertically-disposed distance-rods 58′ or the like, which are preferably secured by one end to the upper carrier and are of suitable length to extend downwardly through suitable apertures in the lower carrier and considerably therebelow when said carriers are at normal separation, and suitable collars, as 80, are adjustably secured on said rods above the lower carrier to insure normal separation of the carriers at a predetermined spacing conforming approximately to the length of the sections which are to be taken from the lower end of the glass tube.

The sections are severed from the glass tube by means of an electric current, which is conveniently applied to the exterior surface of the tube through the medium of an annular-like conductor, as a wire band 81, which is preferably seated in the outer surface of the facing 50 of the clamp 49 adjacent the lower edge in a groove lined with mica and is conveniently electrically connected to a suitable electrical energizer, as a battery, dynamo, or the like, Fig. 2ᴬ, through the medium of suitable electrical conductors. This severing-band is preferably divided so that when the clamp 49 stands open the ends of the wire forming the band will separate more widely and the band will clear the glass tube and when the clamp is closed the band will be brought into contact with the tube. The electrical conductors, as wires 82 and 83, are connected to opposite ends of the severing-band and to the poles of a suitable quick-break switch, as 84, of ordinary construction, and from the opposite poles of this switch electrical conductors, as wires 85 and 86, lead to the battery, and in the line 86 a suitable rheostat, as 87, is connected. Thus it will be seen that by closing the switch 84 and applying the severing-band 81 to the glass tube by closing the clamp 49 the severing-band is made to apply the electric current to heat the glass

along the line of its application to the tube, and thereby create unequal expansion of the glass, which serves to crack same along the line of application, and thereby sever a section of the tube from the main portion.

The apparatus will be operated to form the tube substantially as follows: Both carriers are first brought to a position just below their highest point of travel, with the upper plug 63 in a lowered position, and the wedges are adjusted manually to permit the clamp 49 to stand open and the split nuts 37 closed manually to secure the carriers in position. A suitable gathering-dish coated with plumbago or other material which will prevent adhesion of the glass is then placed beneath the spreader, and the plug 14 is then raised and molten glass passes from the mold and gathers beneath the spreader in the dish, and after a sufficient amount of glass has accumulated in the dish to cover the tip of the blowpipe compressed air is allowed to pass from said pipe into the accumulated mass, and at the same time the dish is lowered at a speed corresponding with the flow of glass from the mold until the lower end of the tube thus started is close to the clamp 49. When the dish is removed and the split nuts opened to allow the weights to raise the upper carrier as the tube enters the open clamp thereon and when the said carrier reaches its highest position, the clamp will close upon the tube by the action of the wedges 52 contacting strike-lug 57, and the split nuts will be closed upon the guide-rods 29 by the levers 38 engaging cams 39. These rods are now set in motion to lower the carrier at the proper speed and the closed end of the tube severed from the body of the tube by the application of an electric current through the severing-band 81. The upper plug 63 is then inserted into the tube at a point above the bottom edge thereof by allowing compressed fluid to pass through conduit 77 into cylinder 61, so as to move the piston-rod 64 upwardly. After this plug is in place the conduit 77 is opened to exhaust, and the piston-rod thus moves away from the plug, which then expands and seals the glass tube. The air is now again turned on and the piston-rod 64 continues to move downwardly until the flange 75′ strikes the cross-head 71, and thereby serves to collapse the lower plug 62. As the upper carrier approaches its lowest point of travel the wedges 52 contact the lower strike-lug 57, and are thereby raised in their seats and release the clamp, which springs open as the split nuts are opened by engagement of respective levers 38 with the lower cams 39, and the weights 45 then act to return the carrier to raised position, when the clamp 49 will be again applied to the glass tube by contact of the wedges with the upper strike-lug as the levers 38 engage the upper cams 39 and serve to close the split nuts for the return of the carrier. As the upper carrier is moving upwardly the lower carrier will follow after until it contacts with the lower end of the glass tube, which will insert the lower plug therein, and the nut parts 37′ are then closed manually by means of levers 38′ and the carrier then starts downwardly. The piston-rod 64 is then again moved upwardly, when the lower plug will expand and seal the tube as the flange on the piston-rod engages the gravity-head of the upper plug and collapses and lifts it upwardly to a position above the lower edge of the clamp 49, when the piston-rod is again retracted, leaving the upper plug in place. Both of the carriers will then be moving downwardly, and the switch 84 is now thrown on to complete the electric circuit, and thereby sever the section of tubing located between the carriers and which rests on the lower carrier from the tubing forming thereabove. Following this the split nuts on the lower carrier are opened and the carrier forced manually to travel downwardly faster than the upper carrier to clear the lower section of tubing from the remainder, which is supported by clamp 49, when the severed portion is presented for removal by tilting the platform and collapsing the lower plug by an inward movement of piston-rod 64. The platform is then reset and the carrier allowed to return by action of the weights 45′ to again engage the lower end of the tubing.

From the foregoing it will be understood that the operation of the appliance is continuous and uninterrupted to carry the tube and repeatedly remove sections thereof and that the speed of the appliance can be regulated in conformity with the flow of glass from the mold by varying the speed of the guide-rods. Furthermore, it will be understood, though the foregoing statement relating to the action of the machine describes the movements as step by step, the operation of the appliance is practically continuous, as the several actions follow each other successively without intermission, so that the molded flow of glass will be properly taken care of.

The apparatus is exceedingly simple of operation, has great capacity of production, and acts positively to produce and handle a continuously-forming glass article from molten glass, and by its use the manual labor required to produce articles of glassware is greatly reduced and an article comparatively superior in symmetry and finish is created at much less cost. Furthermore, by removably arranging the part of the mold at the feed-aperture molds of this class of different sizes and forms can be readily substituted, and by replacing the clamps and plugs with substitutes conforming to the size and shape of the mold substituted the apparatus can be readily changed to produce a glass article of a different diameter and shape without departing from the essence of the invention, which comprehends means

whereby molten glass is fed by gravity and the flow of glass manipulated in a suitable manner to bring it to a desired conformation as it passes from a fluid to a plastic state, and also comprehends means whereby a continuously-forming glass article is produced from a supply of molten glass maintained in any convenient manner in a suitable receptacle.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent of the United States of America, is—

1. In an apparatus of the nature indicated; the combination of a melting-tank having an aperture in the bottom for the feeding out of molten glass by gravity, a spider in said aperture, and a spreader attached directly to said spider and resting in the path of the flow from said aperture.

2. In an apparatus of the nature indicated; the combination of a melting-tank having an aperture in the bottom for the feeding out of molten glass by gravity, a spider in said aperture, a substantially conical-shaped spreader suspended from said spider, and a blowpipe arranged to discharge beneath said spreader.

3. In an apparatus of the nature indicated; the combination of a melting-tank having a feed-aperture in the bottom, a spider in said aperture, a spreader suspended from said spider, a molding-ring about said spreader, and a blowpipe arranged to discharge air beneath said spreader.

4. In an apparatus of the nature indicated; a spreader comprising a substantially conical-shaped body composed of a top section, a base frustum, and means to detachably connect said base to the top section.

5. In an apparatus of the nature indicated; the combination with a melting-tank having a feed-aperture in the bottom; of a mold comprising a molding-ring removably supported at the mouth of said aperture, and a spreader arranged concentric with said ring and comprising a top section supported in said aperture, and a base-section at the outer edge of said ring removably secured to said top section.

6. In an apparatus of the nature indicated; the combination with a melting-tank having a feed-aperture in the bottom; of a molding-ring, and a spreader having an independent conical frustum base, and means to movably secure said base for adjustment relatively to said ring.

7. In an apparatus of the nature indicated; the combination of a melting-tank having a feed-aperture in the bottom, a spider in said aperture, a duct leading from the base of said spider to the exterior of the tank, a molding-ring removably secured at the mouth of said aperture, a spreader removably secured to said spider and having an aperture communicating with said duct and extending to the base, and a downwardly-projecting blowpipe in the aperture in said spreader.

8. In an apparatus of the nature indicated; a mold comprising a molding-ring, and a spreader formed with a removable conical frustum base of substantially equal diameter at the base edge to the bore of said ring and arranged concentric thereto, and means to movably secure said base for vertical adjustment relatively to the ring.

9. In an apparatus of the nature indicated; the combination with a receptacle for molten glass having an aperture arranged for the discharge of molten glass by gravity; of a blowpipe having the tip portion projected and set concentric with said aperture and arranged for discharging air outwardly relatively to the mouth of said aperture.

10. In an apparatus of the nature indicated; a main frame, a reciprocatively-mounted article-carrier, a second reciprocatively-mounted article-carrier below and in alinement with said first carrier and coactingly related thereto, and means to move said carriers reciprocatively.

11. In an apparatus of the nature indicated; a main frame, vertically-disposed carrier-guides an article-carrier mounted on said rods, a second carrier mounted on the guides below said first carrier, and means to raise and lower said carriers.

12. In an apparatus of the nature indicated; a main frame, vertically-disposed, screw-threaded guide-rods rotatably mounted in said frame, a carrier slidably mounted on said rods, guide-engaging nut parts operatively mounted on the carrier, and means to open and close said nut parts.

13. In an apparatus of the nature indicated; a main frame, vertically-disposed guide-rods rotatably mounted in said frame, a carrier slidably mounted on said rods and means to slide said carrier by rotation of said rods.

14. In an apparatus of the nature indicated; a main frame, vertically-disposed guide-rods rotatably mounted in said frame, a carrier slidably mounted on said rods, means to intermittently drive said carrier downwardly by action of the rods, and other means to raise the carrier.

15. In an apparatus of the nature indicated; a main frame, vertically-disposed guide-rods rotatably mounted in said frame, a carrier slidably mounted on said rods, means to normally yieldingly move said carrier in one direction on the rods, and means to intermittently move said carrier in the opposite direction by rotation of said rods.

16. In an apparatus of the nature indicated; a main frame, vertically-disposed, screw-threaded guide-rods rotatably mounted in said frame, a carrier slidably mounted on said rods, rod-engaging nut parts operatively mounted on the carrier, and means to intermittently open and close said nut parts by and during movements of said carrier.

17. In an apparatus of the nature indicated;

a main frame, vertically-disposed, screw-threaded guide-rods, rotatably mounted in said frame, a carrier slidably mounted on said rods, rod-engaging nut parts operatively mounted on the carrier, and adapted for engagement with said rods to drive the carrier downwardly, and counterweights connected to said carrier and arranged to move same upwardly.

18. In an apparatus of the nature indicated; a main frame, vertically-disposed, screw-threaded guide-rods rotatably mounted in said frame, a carrier slidably mounted on said rods, rod-engaging nut parts operatively mounted on the carrier, levers operatively connected to said nut parts, and means to operate said levers by movement of said carrier.

19. In an apparatus of the nature indicated; a main frame, vertically-disposed, screw-threaded guide-rods, rotatably mounted in said frame, a carrier slidably mounted on said rods, counterweights arranged to drive the carrier upwardly, rod-engaging nut parts operatively mounted on the carrier, levers operatively connected to said nut parts, and lever-operating cams arranged at each end of the travel of said carrier.

20. In an apparatus of the nature indicated; the combination of a main frame, a reciprocating carrier, a clamp mounted thereon and means to close said clamp by movement of said carrier.

21. In an apparatus of the nature indicated; the combination of a main frame, a vertically-reciprocating carrier, a clamp mounted on the said carrier and comprising an open annulus having the ends normally yieldingly forced apart, means to close said clamp by movement of said carrier when traveling in one direction, and means to release said clamp to permit it to open by reverse movement of the carrier.

22. In an apparatus of the nature indicated; the combination of a main frame, a vertically-reciprocating carrier operatively mounted in said frame, an article-clamp mounted on said carrier, a second vertically-reciprocating carrier operatively mounted in said frame below said first carrier, an article-receiving platform on the lower carrier, and means to normally hold said carriers at a predetermined distance apart.

23. In an apparatus of the nature indicated; the combination of a main frame, a vertically-reciprocating carrier operatively mounted in said frame, an article-clamp mounted on said carrier, a second vertically-reciprocating carrier operatively mounted in said frame below the said first carrier, an article-receiving platform tiltably mounted on the lower carrier, and means to reciprocate said carriers correlatively.

24. In an apparatus for forming glass tubes; the combination of a main frame, a vertically-reciprocating carrier operatively mounted in said frame, a tube-clamping device mounted on said carrier, a tube-severing device, and operative means to carry the severed tube-section.

25. In an apparatus for forming glass tubes; the combination with a molding-ring and a blowpipe; of a main frame, an upper and a lower carrier operatively mounted in said frame for vertical reciprocating travel; a tube-clamping device on the carrier nearest said ring and a tube-sealing device on the other carrier.

26. In an apparatus for forming a glass tube; the combination with a receptacle for molten glass, a horizontally-disposed molding-ring arranged for the passage of glass directly from the receptacle through the ring, and a blowpipe arranged to discharge into the glass passing through the ring; of a main frame a carrier mounted therein and a tube-clamping device mounted on said carrier.

27. In an apparatus for forming a glass tube; the combination with a receptacle for molten glass, a horizontally-disposed molding-ring arranged for the passage of glass directly from said receptacle through said ring, a blowpipe arranged to discharge into the glass passing through the ring; of a main frame, a vertically-reciprocating carrier, operatively mounted in said frame, a tube-clamping device mounted on said carrier, and a tube-sealing device.

28. In an apparatus for forming a glass tube; the combination with a receptacle for molten glass, a horizontally-disposed molding-ring, and a blowpipe; of a main frame, a vertically-reciprocating carrier operatively mounted in said frame, a tube-clamping device mounted on said carrier, a second reciprocating carrier mounted below said first carrier, a tube-sealing device mounted on said second carrier, an expandible, tube-entering plug, and means to collapse and move said plug when in the tube.

29. In an apparatus of the nature indicated; means to transform a continuous flow of molten glass into a continuously-forming tubular article, means to movably support said article as formed, means to apply an electric current to sever sections from said article, and an electrical energizer electrically connected to said severing means.

30. In an apparatus of the nature indicated; a movably-mounted glass-article carrier, an operably-mounted electric glass-heating device yieldingly held in retracted position, means to advance said device relatively to said article by a movement of said carrier, and an electrical energizer electrically connected to said device.

31. In an apparatus of the nature indicated; means to convert a continuous flow of molten glass into a continuously-forming glass tube, a carrier movably mounted for travel relatively to said converting means, a clamp for said tube comprising an open annulus mounted on said carrier, an electrical tube-severing de-

vice comprising an open annular electric conductor seated in the face of said clamp, and an electrical energizer electrically connected to said conductor.

32. In an apparatus for forming glass tubes; the combination with a mold having a bottomless tube-molding channel; of a blowpipe and a plurality of tube-entering sealing-plugs.

33. In an apparatus for forming glass tubes; the combination with a mold having a bottomless tube-molding channel; of a blowpipe, removable means to seal the end of the tube, as formed in said channel, a collapsible tube-entering plug, and means to move said plug in the tube.

34. In an apparatus for forming glass tubes; the combination with a mold having a bottomless tube-molding channel; of a blowpipe, a collapsible plug adapted to seal the tube as formed in said channel, and a second collapsible plug adapted for insertion in said tube below first said plug.

35. In an apparatus of the nature indicated, a frame, a receptacle for molten glass having a feed-aperture, a plurality of carriers mounted on the frame and being adapted to engage the glass at spaced-apart points as it flows from the aperture of said receptacle, and means for moving said carriers.

36. In an apparatus of the nature indicated, a main frame, a pair of carriers arranged therein, means for moving said carriers simultaneously in one direction, and means for moving said carriers independently in the reverse direction.

37. In an apparatus of the nature indicated, screw-rods, a carrier supported thereon, means for rotating said rods, means carried by the carrier for engagement with said rods whereby the carrier is moved, and means for disengaging said last-named means from operative engagement with the rods.

38. In an apparatus of the nature indicated, screw-rods, a carrier supported thereon, means for rotating said rods, means carried by the carrier for engagement with said rods whereby the carrier is moved, and means for opening and closing said last-named means.

39. In an apparatus of the nature indicated, in combination with a tube-forming means, a plurality of tube-sealing plugs, and means for raising and lowering the said plugs, substantially as specified.

40. In an apparatus of the nature indicated, in combination with a tube-forming means, a plurality of tube-sealing plugs, means for raising and lowering said plugs, and means for expanding and contracting said plugs.

41. In an apparatus of the nature indicated, a receptacle for molten glass having an aperture for the feeding out of said molten glass, an open supporting means secured in said aperture, and a spreader secured directly to said supporting means.

42. In an apparatus of the nature indicated, a receptacle for molten glass having an aperture for the feeding out of said molten glass, a spreader mounted in said aperture, and a removable base for said spreader having a tapered edge, substantially as and for the purpose specified.

43. In an apparatus of the nature indicated, a receptacle for molten glass having an aperture for the feeding out of the molten glass, a transverse supporting means in said aperture formed with a duct, and a spreader secured to said supporting means and being formed with a channel communicating with said duct.

44. In an apparatus of the nature indicated, a receptacle for molten glass having an aperture for the feeding out of the molten glass, a supporting means in said aperture formed with a duct, and a spreader secured to said supporting means and being formed with a channel communicating with said duct, and a blowpipe secured in said channel and projecting without the same.

45. In an apparatus of the nature indicated, a carrier, means for raising and lowering the same, and means for automatically releasing and connecting said carrier with said means at predetermined points of travel of the carrier.

46. In an apparatus of the nature indicated, a tube-forming means, a carrier for the tube being formed, means for severing the tube being formed intermediate the forming means and the carrier, and means for closing the tube above the point of severance.

47. In an apparatus of the nature indicated, a tube-forming means, means closing the lower end of the tube being formed, a severing means, and a plug movable into the tube being formed above said severing means.

48. In an apparatus of the nature indicated, a receptacle having an aperture for the feeding out of molten glass in hollow form, means below said receptacle for successively severing sections from the glass as it is fed, means for conveying each section when severed, and means for closing the lower end of the glass being fed during the removal of a section when severed therefrom.

49. In an apparatus of the nature indicated, a tube-forming means, a carrier for the tube being formed, and a plug movable above the carrier and into the tube being formed.

Signed at Seattle, Washington, this 7th day of February, 1903.

DANIEL MURRAY.

Witnesses:
ERNEST B. HERALD,
JAMES R. SMITH.