Sept. 29, 1953 B. SHAW 2,653,418

APPARATUS FOR DRAWING VITREOUS TUBES AND RODS

Filed Oct. 13, 1949 3 Sheets-Sheet 1

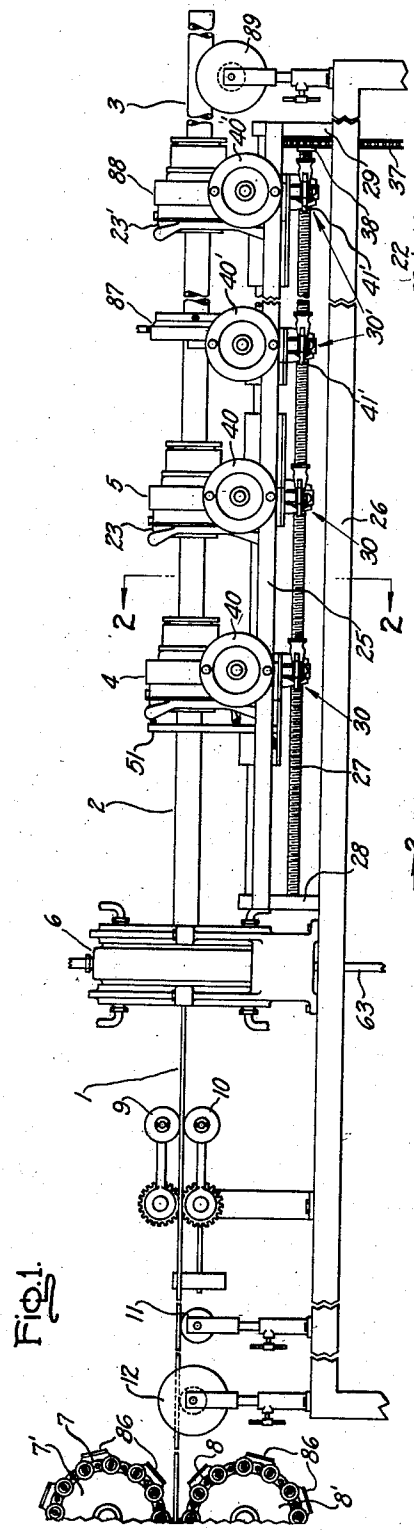

Fig. 1.

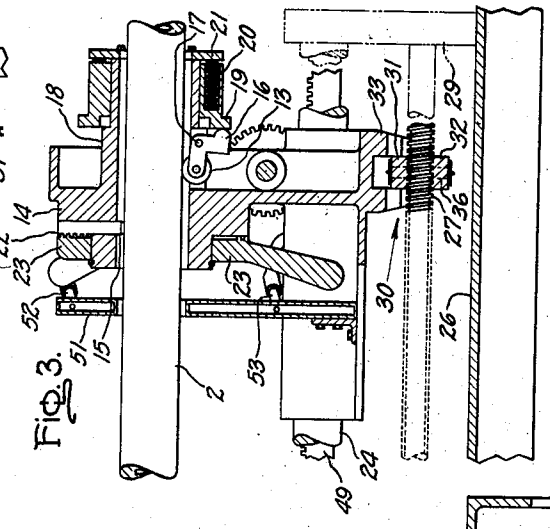

Fig. 3.

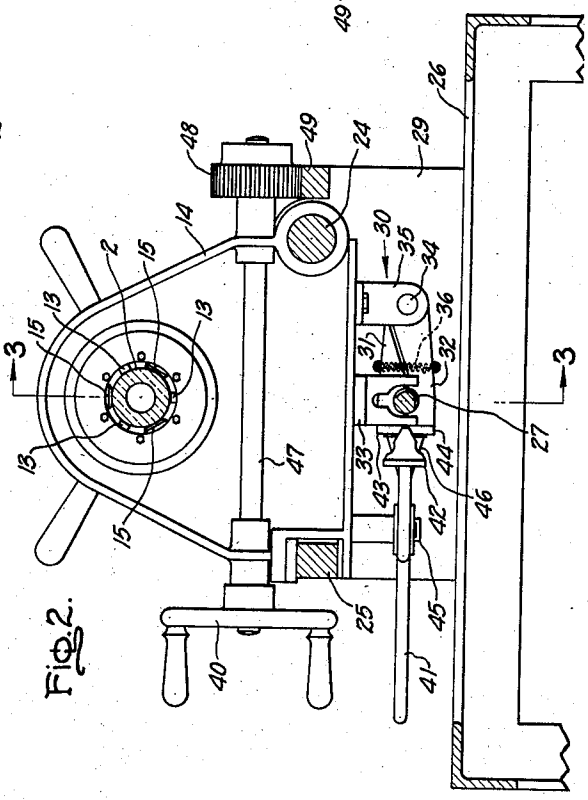

Fig. 2.

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Fig. 4.

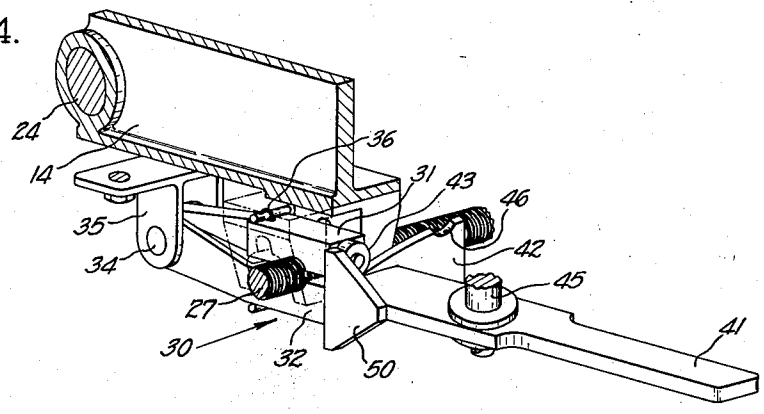


Fig. 6.

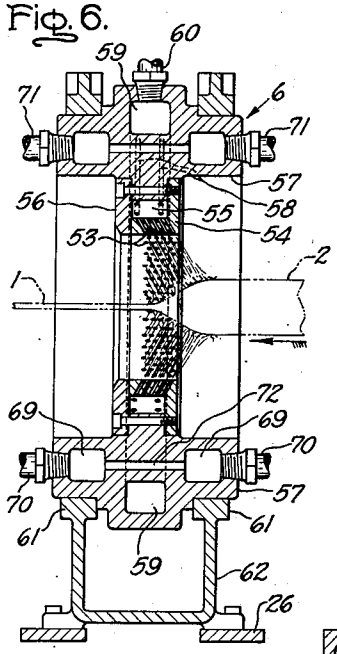


Fig. 5.

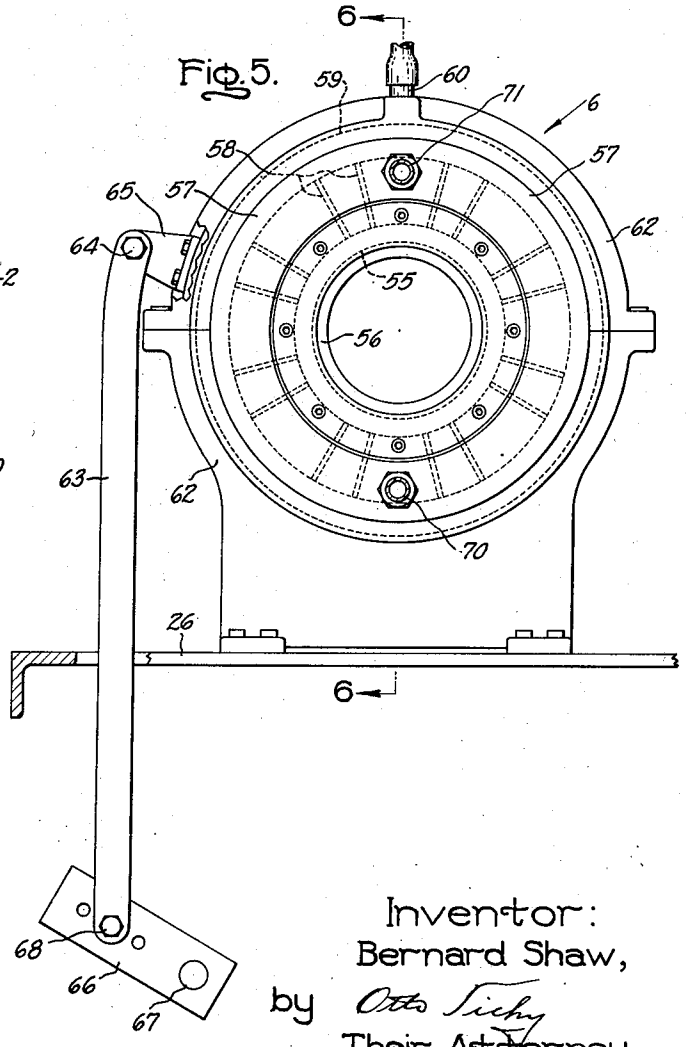


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Fig. 7.

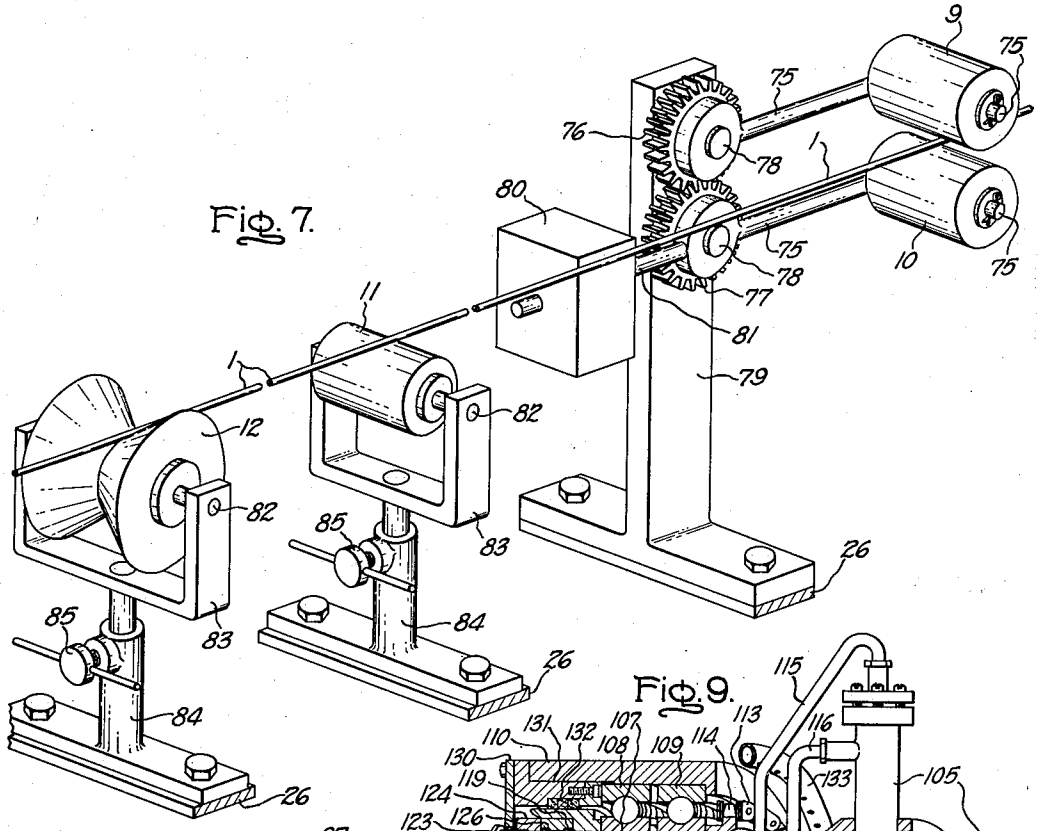



Fig. 8.

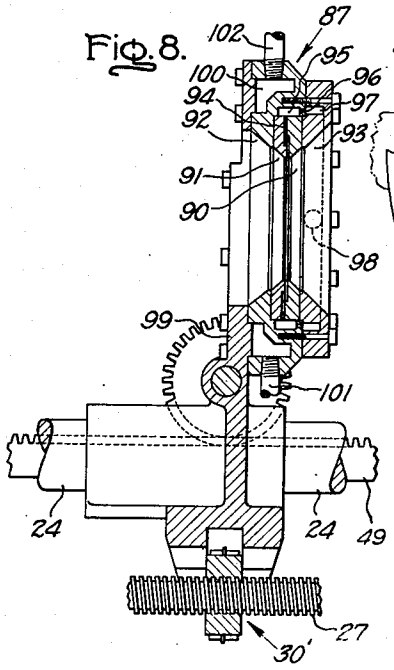
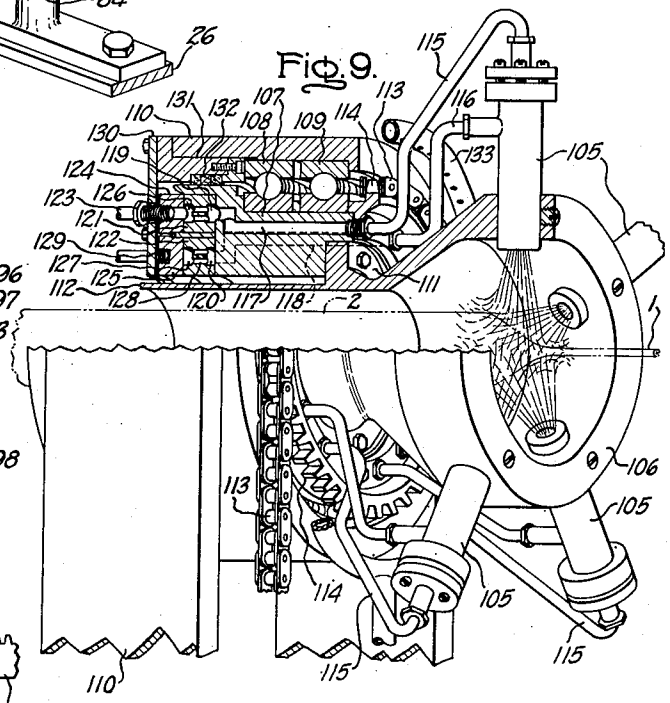



Fig. 9.

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Patented Sept. 29, 1953

2,653,418

# UNITED STATES PATENT OFFICE

2,653,418

## APPARATUS FOR DRAWING VITREOUS TUBES AND RODS

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Application October 13, 1949, Serial No. 121,206

8 Claims. (Cl. 49—17.1)

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My invention relates to apparatus for drawing tube or rod of a vitreous material, particularly quartz or a glass of high silica content. More particularly, my invention relates to the drawing of tube or rod from a slug of vitreous material characterized by the heating of a slug of said material and the drawing of said tube or rod therefrom.

One object of my invention is to circumvent the many difficulties of drawing certain very high-temperature-melting materials directly from a molten or semi-fluid state by drawing a tube or rod, as the case may be, from a slug and by effecting the drawing of said tube or rod therefrom in a manner adapted to ready control, to high speed operation and maintained accuracy of operation. To this end, apparatus is provided for automatically introducing a very large quantity of heat uniformly into a definite restricted area of a slug, for drawing off in the form of tube or rod under controllable conditions the heated portion of the slug and for continuously advancing additional portions of the slug to proper operating relation to the heating means under the particular conditions of operation. The satisfactory coordination of the heating, drawing and feeding operations in a manner suitable for low cost commercial production of quartz and related materials is afforded by my invention.

Another object of my invention is to provide an apparatus which permits high drawing speeds, extended drawing intervals and convenient and quick changes in size and the form of the tube (single or multiple bore for instance) or rod being drawn. Heretofore, the skill of the operator was in a very large measure responsible for most drawing conditions throughout the drawing interval because of difficulty in heating the slug uniformly and of other variables created by repeated introduction of slugs and short drawing intervals. The present drawing apparatus provides a particularly controllable source of heat for melting the slug in a group of burners which are rotated about said slug and is particularly suited to operate with relatively long slugs, eight feet in length, for instance. Such slugs can be made by sealing several shorter slugs together in end-to-end relation. The use of long slugs greatly reduces losses in that the pieces of unusable slug material remaining at the end of the draw are virtually eliminated and in that few pieces of slug are then too short to permit completion of a single size draw and must be discarded.

Another object of my invention is to provide apparatus for drawing tube or rod continuously

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from a slug of vitreous material and for adding other slugs to the end of the first slug without interruption of the drawing operation. The maximum flexibility, accuracy in control and economy of operation are realizable by the continuous manner of operation. A preferred apparatus fulfilling the above objects combines either the endless belt or wheel type drawing means, which are capable of continuous operation, with means adaptable to uninterrupted slug feeding and means for sealing an additional slug to the free end of the slug in the operative position.

Still other objects and advantages of my invention will appear from the detailed description which follows and from the drawing.

In the drawing, Fig. 1 is a side elevation of drawing apparatus of my invention which elevation is foreshortened by having various transverse sections of uniform construction along its length broken therefrom; Fig. 2 is a sectional view taken from the vertical plane established by the dot-dash line 2—2 of Fig. 1 and showing in particular one of the slug-supporting chucks and the adjacent portion of the bed of the apparatus; Fig. 3 is a vertical section along the dot-dash line 3—3 of Fig. 2 showing said chuck and bed portion; Fig. 4 is a perspective view of a broken away portion of the chuck including the clutch for controlling the automatic feed motion thereof; Figs. 5 and 6 are end and sectional views of the burner assembly of the apparatus; Fig. 7 is a perspective view of the guiding and supporting members of the apparatus engaging the drawn tube or rod; Fig. 8 is a vertical section through the slug-joining burner along the drawing axis of the apparatus; and Fig. 9 is a perspective view of a modified burner assembly for use in the drawing apparatus of Fig. 1, the view being qualified by removal of an upper quarter section of said burner.

The apparatus appearing in Fig. 1 effects the drawing of a small tube 1 of quartz from the end of a relatively large tubular slug 2 and represents one form of the apparatus featured by a horizontal drawing axis which permits all phases of the drawing operation to be conveniently observed and controlled by a single operator. The apparatus, as will be described further along in this disclosure, can also be arranged so as to have an oblique or vertical drawing axis. Another principal feature of the apparatus appears in means permitting the drawing operation to be continued indefinitely by providing for the successive addition of other slugs, such as that slug shown at 3, to the free end of the first slug 2 opposite that from which the drawing is taking

place. The addition of slug 3 is controlled by the operator and is used both to supply additional slug and, if required, on occasion, to introduce differently-formed slugs into the apparatus.

The main slug 2 is usually about eight feet in length when the apparatus is initially set up for operation and is fixed on the drawing axis by the support and gripping functions of the chucks 4 and 5 which engage spaced portions thereof. Automatically established movements in the chucks 4 and 5 advance the slug 2 along the drawing axis and into the cone of flame emitted by the burner assembly 6 where the end thereof is heated to drawing temperature. The smaller tube 1 is drawn from the heated end of the slug 2 by pulling means of the usual design which is herein represented only by the portion of the endless belts 7 and 8 shown and passes to said pulling means, which is spaced some distance from the burner assembly 6, over a path carrying it between rollers 9 and 10 and over the support rollers 11 and 12. The size of the drawn tube 1 is dependent upon automatic functions of the apparatus affecting both the slug 2 and the tube 1, in particular, the rate of advance of the slug 2, which is associated with the feeding of heated quartz, and the rate of movement of the pulling means, which draws off the finished tube 1. To this end, it is preferred that the pulling means herein represented by the endless belts 7 and 8 be that apparatus disclosed in Danner Patent 1,220,201, dated March 27, 1917, which is independently driven and which is capable of operating at minutely different speeds upon manual adjustment, or a wheel type apparatus which is correspondingly driven. Other features and advantages of my invention will appear in the detailed description, which follows, of the apparatus disclosed in the drawing.

In normal operation periods, the slug 2 is supported and gripped correspondingly by each of the chucks 4 and 5, which are substantial duplicates, and takes proper alignment with the drawing axis because of the cooperative centering function of supporting and gripping means associated with each chuck 4 or 5. As shown in combination with the chuck 5 disclosed in detail in Figs. 2 and 3, the slug 2 is supported between three equidistantly spaced support rollers 13 located about a passage through the carriage 14 forming the body of the chuck 5 and is also gripped between three equidistantly spaced jaws 15 located intermediate said support rollers 13 in radially extending slide ways in said carriage 14. The support rollers 13 have no other function than to center the slug 2 within the chuck 5 and are not capable of independent control as are the jaws 15 which can be released from their grip on the slug 2 to allow the chucks 4 and 5 to be repositioned along the length thereof. Each roller 13, as shown in the single combination appearing in Fig. 3, is mounted upon a lever 16 pivoted upon a pin 17 bridging a slot within an axially extending boss 18 of the carriage 14 and is influenced by the pressure of engagement of the sleeve 19 with said lever 16. The presence of the slug 2 between the rollers 13 further increases the pressure of the engagement as the outward movement of ends of the levers 16 forces the sleeve 19 back against the resistance of helical springs 20 located between said sleeve 19 and the collar 21 fastened to the end of the boss 18. Inasmuch as all three rollers 13 are under equal influence by the sleeve 19, the pressure of engagement of the rollers 13 with slug 2 is always equal and centers said slug 2 regardless of its size. The jaws 15 of the chuck 5, on the other hand, are under the control of the engagement of the teeth of a gear rack 22 along their extremities with teeth in the form of spiral-shaped ridges around the adjacent face of a rotatable ring 23 and are adjusted toward and away from the slug 2 by manually-produced rotative movements of the ring 23 which advance radially-displaced portions of said teeth or ridges into engagement with the jaws 15. Handles projecting from the periphery of the ring 23 permit the ready manipulation thereof. No independent movement of the ring 23 can occur as the teeth or ridges therein have such a gradual spiral form about the center of chuck 5 as to cause said ring 23 to be immovable by pressure exerted by the jaws 15.

In normal operative periods, the slug 2 is being advanced into flames emitted from the burner assembly 6 by movement of both chucks 4 and 5 as both are adjusted so as to grip the slug 2 and as both are correspondingly influenced by feeding means. The chucks 4 and 5 are slidable upon the fixed rod 24 and bar 25 lying above the bed 26 of the apparatus and are moved by the rotation of the feed shaft or screw 27 which lies below and midway between said rod 24 and bar 25 and which is mounted together therewith on the cross plates 28 and 29 on said bed 26. A clutch 30 located upon the lower surface of the carriage 14 of each chuck 4 and 5 forms the means of engaging the feed screw 27 and provides (as shown in detail in connection with chuck 5) two pivoted arms 31 and 32 closing against said feed screw 27 from opposite sides in the manner of a split nut. Complementary threads in the arms 31 and 32 engage the threads along the feed screw 27 and cause movement of said arms 31 and 32 along the screw 27 in accord with rotation thereof which motion is transferred to the carriage 14 in that said arms 31 and 32 are located between fixed arms of a yoke 33 extending from the lower surface thereof. The arms 31 and 32 are pivoted upon a pin 34 carried by a bracket 35 on the bottom surface of carriage 14 and are constantly being pulled against the feed screw 27 at moments of engagement of the clutch 30 by a helical spring 36 located within an opening in said arms 31 and 32 and hooked onto pins straddling said opening. It is preferred that the rotation of the feed screw 27 be capable of very accurate control to enable the rate of feed of the slug 2 to be matched to the drawing requirements and to this end it is preferred that drive means (not shown) separated from the other operative functions of the apparatus be provided. The drive means rotates said screw 27 through the chain 37 which passes around the sprocket 38 at one end thereof.

Gradual consumption of the slug 2 during the drawing operation and the continued movement of the chucks 4 and 5 always toward the burner assembly 6 make the rearrangement of said chucks 4 and 5 along said slug 2 toward the opposite end of the apparatus necessary for continuous production. This rearrangement of the chucks 4 and 5 is performed manually by moving first one then the other of said chucks 4 and 5 outward away from the burner assembly 6 so that both chucks 4 and 5 continue to support the slug 2 while one chuck 5 or 4 continues to advance the slug 2. The rearrangement of each chuck 4 or 5 is effected by first rotating the ring 23 thereof to release the slug 2 from the grip

thereof, in then releasing the clutch 30 of said chuck to disconnect it from the feed screw 27 and then in repositioning said chuck 4 or 5 along the support rod 24 and bar 25 by rotation of the hand wheel 40. The particular chuck 4 or 5 being repositioned continues to hold the slug 2 in proper alignment in the apparatus in that the support rollers 13 thereof continue to press against said slug 2. The above order of manual operation is preferred since it releases the chuck 4 or 5 from the slug 2 prior to disconnecting it from the feed screw 27 thereby preventing any drag on the slug 2 by an idle chuck 4 or 5. Release of the clutch 30 is effected by manually swinging the control lever 41 thereof from left to right so that the wider portion of the arcuate wedge 42 (Figs. 2 and 4) on the inner end of said lever 41 is forced between the rollers 43 and 44 on the ends of said arms 31 and 32 respectively and the said arms 31 and 32 are spread outward and disengaged from the threads of the feed screw 27. The control lever 41 is pivoted upon a pin 45 extending from the carriage 14 and completes its movement thereabout when the rollers 43 and 44 fall into corresponding notches 46 in the wedge 42 serving to hold said wedge 42 and the clutch 30 in the open position. Normally, the chuck 5 farthest from the burner assembly 6 must be repositioned first to avoid interference between the chucks 4 and 5 and is moved in a direction away from the burner assembly 6 by initiating a clockwise rotation in the hand wheel 40 associated therewith. The hand wheel 40 is attached to one end of the shaft 47 in bearings within the carriage 14 and turns a spur gear 48 meshing with a stationary rack 49 adjacent the opposite end of said shaft 47 so that the carriage 14 is pulled along the support rod 24 and bar 25. The stationary rack 49 corresponds to the rod 24, bar 25 and feed screw 27 in that it is supported and held in position by the supports 28 and 29 at spaced points along the bed 26 of the apparatus. Re-establishment of the chuck 5 as a means of moving the slug 2 is effected by first re-engaging the clutch 30 thereof with the feed screw 27 through a manual adjustment of the control arm 41 and then, after a moment of time which permits the full re-engagement of the clutch 30 and said chuck 5 to take up the feeding motion, causing said chuck 5 to grip the slug 2 by manually rotating the ring 23. At the fully engaged position of the clutch 30 the rollers 43 and 44 thereof are spaced from the surface of the narrow end of the wedge 42 and usually butt against the right angle flange 50 on the control arm 41 which is limited in its movement thereby. The position of chuck 4 can now be changed in the same manner without disturbing the drawing operation which is then dependent upon the motion of chuck 5 for movement of the slug 2. A water-cooled shield 51 is mounted upon the carriage 14 of the chuck 4 at the side thereof adjacent the burner assembly 6 to prevent the intense heat radiations from the general area thereof from excessively heating the manual controls and other parts of said chuck 4. The sideward and endward extending pipes 52 and 53 which connect to flexible hose (not shown) provide for the circulation of cooling water through the hollow interior of the shield 51.

The slug 2 is retained upon an axis running through a relatively large center opening of the burner assembly 6 as indicated in Fig. 6 and in the course of its advance toward the burner assembly 6 is automatically introduced into a cone of burning mixed gases discharged from a multiplicity of orifices 53 in the internal ring 54 thereof. The great volume of heat required to heat the quartz slug 2 to a semi-plastic or drawable condition is generated by the burning of a suitably proportioned mixture of hydrogen and oxygen gases, a gas mixture which passes into the orifices 53 from a surrounding chamber 55 formed by the ring 54, cover plate 56 and the burner body 57. Radially extending passages 58 at spaced intervals around the burner body 57 conduct the gases to chamber 55 from a circular distribution manifold 59 in the outer portion of the burner body 57, which manifold 59, in turn, is fed by supply pipes 60 (only one being shown) connected by flexible hose to sources of supply. Although the cone of flame developed by the burner assembly 6 is very uniform throughout, means are provided in the assembly for effecting oscillation of burner body 57 and accordingly of the flame around the slug 2 so that any unbalance that may occur is neutralized. The burner body 57, which is generally circular in shape, is mounted through hollow circular bosses on opposite faces resting upon seating rings 61—61 provided by the support housing 62 and is connected by flexible hose (not shown) to the gas sources so as to be capable of independent rotation. The motion of burner body 57 occurs in all periods of operation of the apparatus and appears as oscillatory back and forth movements of approximately 40 degrees initiated by up and down movements of the connecting bar 63 which is attached to said burner body 57 by pin 64 and bracket 65. A crank 66 attached to a shaft 67 of a constantly rotated source, the drive shaft of an electric motor driven speed reducer for instance, provides the means of actuating the connecting bar 63 which is attached thereto by pivot bolt 68.

The heat generated by the burning gas emitted by the burner assembly 6 is concentrated as much as possible within a very limited area of the quartz slug 2; however, considerable radiation of heat occurs therefrom and means are provided to forcibly cool the burner assembly 6 to keep it within a practical working temperature. Circular passages 69—69 around the bosses on opposite faces of the burner body 57 contain the cooling liquid, preferably water, which is introduced into and drained from the burner body 57 through the pipes 70 and 71 respectively and connected flexible hose (not shown). Still further cooling is effected by the circulation of the liquid through a plurality of connecting passages 72 located around the burner body 57 between the circular passages 69—69 therein.

The flames from the burner assembly 6 effect an almost perpendicular slope to the end surfaces of the slug 2 at the position where it draws down into the diameter of the tube 1 and maintains this condition because of the constant advance of the slug 2 which arranges a further extent thereof at said position as rapidly as said slug is consumed. Normally the feeding and heating functions of the apparatus are continuous and are synchronized with a steady drawing of tube 1 from the slug 2.

The tube 1 drawn from the end of the slug 2 is pulled along a drawing axis in alignment with said slug 2 and takes a uniform size because of the constant drawing speed which is set up to pull heated slug material from the flames of burner assembly 6 as rapidly as it becomes workable. The heating, feeding and drawing functions of the apparatus are all contributing factors in

the drawing of a specific sized tube and accordingly are separately adjustable to permit the apparatus to draw a particular sized tube 1. Normal operation procedure is to allow the heating and feeding to continue at matched rates and to control the drawing operation largely by varying the speed of the draw so that the size of the tube 1 pulled from the slug 2 takes the desired size. It is accordingly preferable although not positively required that some easily adjustable means such as that disclosed in Danner Patent 1,220,201 hereinbefore referred to and represented by the partial showing of the drawing chains 7 and 8, be provided to pull the tube 1 from the slug 2. The drawing means (chains 7 and 8) is located along the drawing axis some distance from the burner 6, in order to engage a portion of the tube 1 which has cooled somewhat and which is therefore not readily deformable, and is associated with the supporting and guiding means (Figs. 1 and 7) in the self-centering rollers 9 and 10 and the rollers 11 and 12 located along the extent of the bed 26 of the apparatus therebetween. Because of the relatively close proximity of the rollers 9 and 10 to the burner assembly 6, they are preferably made of graphite so as not to stick to the hot tube 1 and be injured by the heat thereof and are movably supported by means keeping them equal distance above and below the drawing axis of the tube 1 so that said tube 1 in turn is kept straight. The rollers 9 and 10 turn freely about the right-angle end portions of the arms 75—75 respectively which are mounted upon integral bosses of the intermeshing gears 76—77 respectively and are restricted to equal movements with relation to the drawing axis in that said gears 76 and 77 must turn correspondingly about the pivot pins 78—78 extending from the support standard 79. Both rollers 9 and 10 are constantly biased toward each other with sufficient pressure to effect the guiding and supporting function by the gravitational pull of the weight 80 on the arm 81 extending from gear 77 but do not press against the tube 1 with sufficient pressure to cause said rollers 9 and 10 to deform it. The support rollers 11 and 12 are flat and cone-shaped graphite elements respectively located adjacent the drawing axis and are correspondingly mounted upon a pin 82 extending across a vertically adjustable yoke 83 carried by a support standard 84. The thumb screws 85 in the support standards 84 permit the center leg of the yokes 83 to be clamped at a position within the support standards 84 which position the roller 11 or 12 at the proper position to hold the tube 1 in alignment with the drawing axis. The pulling means, which is next in the order of engagement with the tube 1, effects this engagement through pads 86 at intervals along the chains 7 and 8 which pads 86 are brought into engagement with opposite sides of the tube 1 by rotation of the sprockets 7' and 8' carrying said chains 7 and 8 into operative relation thereto.

The heretofore described apparatus is an operative unit having particular advantage in that it is readily adjusted to draw different size tubing or rod and can be adjusted without interruption in the normal continuous cycle of operation. The extent to which these advantages are recovered is dependent on the presentation of a continuous supply of slug to the drawing position within the burner assembly 6 and in the present apparatus is cared for by means adding to the length of slug 2 by providing for the sealing of a second slug 3 to the end of said slug 2 without interrupting the drawing operation. Other slugs can be added to the particular slug in the drawing position in a like manner so as to further perpetuate the drawing operation and extend the drawing operation in definitely and allow the fullest recovery of the above advantages to be received. The continuous cycle of operation avoids the loss of productive time, unusable short slugs and considerable off-size drawn materials during the various setup periods that are otherwise required. This manner of operation is also adaptable to the introduction of differently formed slugs into the drawing apparatus inasmuch as a slug of different size or cross section can be added to slug 2 and advanced into the drawing position thereby if desired.

As shown in the instance in the drawing, the slug 3 is added to the end of slug 2 through the sealing function of the flames from a burner 87 (Figs. 1 and 8) while being held in butted relation and alingnment with said slug 2 by chuck 88 and support roller 89. The slug 2 continues to be advanced into the burner assembly 6 at such times and movements developed in the burner 87 and the chuck 88 are depended upon to maintain the sealing flames and slug 3 in proper arrangement thereto.

The slug 3 is first introduced into the apparatus by resting it upon the roller 89, which is a duplication of roller 12 at the opposite end of the apparatus, and then moving it lengthwise to thread the forward end through the chuck 88 and bring said end to close proximity to the end of slug 2. The burner 87 and chuck 88 are both slidably mounted on an extent of the rod 24 and bar 25 in the manner of the previously described chucks 4 and 5 and have previously been arranged therealong at positions causing the flames to wipe the end surface of slug 2, and the chuck 88, with the assistance of roller 89, to properly support the slug 3. At the time of arrangement of the burner 87 and chuck 88, said burner 87 and chuck 88 are also coupled to the feed screw 27 by manual manipulation of the clutch control levers 41' so that the rotation of the screw 27 advances them at the same rate as the slug 2 and maintains their relation thereto. The control levers 41' effect operation of clutches 30' in combination with the burner 87 and chuck 88 which are duplicates of the chuck 30 in combination with chucks 4 and 5 previously described in detail and in their association with the hand wheel 40' and other means, which are also duplicates of means in combination with chucks 4 and 5, provide for movement of said burner 87 and chuck 88 both mechanically and manually as required.

The slug 3 is advanced manually through the chuck 88 until the end surface of said slug 3 is wiped by the flames from the burner 87 whereupon it is clamped in said chuck 88 so that the automatic advance thereof maintains its relative position. The clamping action of the chuck 88 which is a duplication of chucks 4 and 5 is effected through manual rotation of the ring 23' thereof.

At the present position of the slugs 2 and 3, an inwardly directed circle of flame developed by burning gases discharged through the slit between the rings 90, 91 (Fig. 8) of the burner 87 passes into the space between the ends of said slugs 2 and 3 and over immediate end portions thereof. The flame is uniform throughout the full circle although the rings 90 and 91, which are

clamped tightly to the burner body 92 by the retaining ring 93, are separated by narrow radial ridges 94 in the adjacent faces thereof. The combustible gas enters the discharge slit of the burner 87 from a circular distribution chamber 95 in the burner body 92 about the periphery of the rings 90 and 91 and passes thereto through short connecting passages 96 from a passage 97 within the retaining ring 93 which is fed by flexible piping (indicated at 98) leading from the source of supply. The burner 87 is supported by the carriage 99 which is slidable upon the bed formed by rod 24 and bar 25 and restricts the flow of heat absorbed thereby to the other portions of the apparatus by providing for the circulation of cooling water through the circular passage 100 in the burner body 92. Flexible pipe connections (not shown) made to pipe nipples 101 and 102 provide for the feeding and draining of the cooling water from passage 100.

When the adjacent end portions of the slugs 2 and 3 have been subjected to the flames from burner 87 for a sufficiently long interval to permit them to be sealable, the control arm 41' on the clutch 30' of the slug-supporting chuck 88 is moved to the release position and said chuck 88 is manually advanced toward burner 87 by rotation of the hand wheel 40' to force the slugs 2 and 3 into engagement. Further working of the seal by effecting short back-and-forth movements of the chuck 88 and slug 3 is usually desirable to control the joined portions and assure thorough sealing. The position of the burner 87 can also be moved at this time if desired; however, it must first be disconnected from the automatic feed means by adjustment of the clutch control arm 41'. The hand wheel 40' permits the burner 87 to be moved in the same manner as the chuck 88. The need for the flames from burner 87 is no longer present after the slugs 2 and 3 are sealed together and the gas supplied thereto is valved off to extinguish the flames.

After the slugs 2 and 3 have been joined together, the slug 2 has usually been consumed sufficiently to make it desirable to reposition the chuck 4 so as to prevent it from striking the burner assembly 6 and also to reposition chuck 5 so as to redistribute the weight of the composite slug 2—3 between the chucks 4, 5, and 88. The rearrangement of chucks 4 and 5 is effected by the operator first repositioning chuck 5 further away from the burner assembly 6 and then moving chuck 4 back correspondingly. The presence of chuck 88 as a supporting element for the slug 2—3 during the rearrangement of the chucks 4 and 5 assists in maintaining the accurate alignment thereof with the drawing axis. The burner 87 and chuck 88 can similarly be moved outward from burner assembly 6 at any time during the operation of the apparatus without disturbing the operation thereof.

The modified burner assembly appearing in Fig. 9 is an alternate form of heating means adaptable for use in the drawing apparatus heretofore described and provides a grouping of burners 105 adapted for continuous rotation around the slug 2. The modified burner assembly is particularly usable in the drawing of the larger sizes of tubing or rod 1 because the larger possible capacity of the burners 105 and is also particularly usable when said apparatus is mounted vertically or inclined vertically, as is preferred when certain larger sizes of tubing or rod 1 are being drawn and there is some possibility that the heated end of the slug 2 will tend to sag to an off-center position in a burner assembly in horizontally arranged apparatus. An off-center condition cannot be allowed to exist in the drawing apparatus since the heated end of the slug 2 loses its circular form and the action of the flames from the burner produces a drawn product of out-of-round form and, in the case of tubing, produces a product of uneven wall thickness.

The burners 105, of which there are five equidistantly spaced about the flared outer end of the core 106 of the burner assembly, are shown in full detail in United States Patent 1,729,677, dated October 1, 1929, Miller and are maintained along the drawing axis of the apparatus through the attachment of the core 106 to the rotatable sleeve 107 which is, in turn, mounted in the inner races of the ball bearings 108 and 109 retained by the support housing 110. Contact between the core 106 and the sleeve 107 is limited to a flange 111 at one end of the core 106 so as to restrict the passage of heat therebetween. Further protection is afforded the sleeve 107 and associated means by the axially extending shield 112 which extends from the end of the core 106. The burners 105 are caused to heat the full periphery of the slug 2 uniformly under the influence of a rotative movement introduced in the assembly by a chain 113 engaging a sprocket 114 attached to the sleeve 107, which movement is produced by a source (not shown) actuated throughout the operative period of the apparatus at a uniform rate. The combustible and combustion supporting gases are supplied to each burner 105 separately by means of the pipes 115 and 116 which are similarly connected through openings in the sprocket 114 to adjacent longitudinal passageways 117 and 118 in the sleeve 107 and have sources common to each gas in the channels 119 and 120 completely around seal rings 121 and 122 at the opposite end of the sleeve 107. Several stationary sources of the gases corresponding to the pipe connection 123 are provided in the glands 124 and 125 which bear against the outer surface of the seal rings 121 and 122 and which discharge into respective outer channels 126 and 127 in said seal rings 121 and 122 and are the main stationary source of supply of these gases. Communication between the outer channels 126 and 127 and the inner channels 119 and 120 in the seal rings 121 and 122 is given by a multiplicity of openings 128. The seal rings 121 and 122, which are formed from non-porous type graphite, form a permanent seal between the rotating and non-rotating parts of the burner assembly under the pressure of the glands 124 and 125 which are backed at intervals thereabout by helical springs like that shown at 129. A cover plate 130 and means including the retaining ring 131 and packing 132, which form the grease sealing means of the burner assembly constitute the only other integral elements thereof. Under certain conditions of operation more satisfactory control of the temperature of the burner assembly can be maintained by artificially cooling that portion of the core 106 of said assembly. In the instance shown, such cooling is effected by jets of air directed against the flared walls of said core 106 from openings in a ring-shaped manifold 133 located adjacent the end of the housing 110 and outside the rotative field of the burner parts.

Although preferred embodiments of my invention have been disclosed, it will be understood that the invention is not to be limited to the specific construction and arrangement of parts shown, but that they may be widely modi-

fied within the spirit and scope of my invention as defined by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for drawing tube or rod from a vitreous slug comprising heating means, spaced chucks to one side of and in alignment with the heating means and movable toward and away therefrom having separate releasable means for gripping and means for aligning a slug therewith, means for selectively moving both the chucks at corresponding speeds rectilinearly toward the heating means to advance one end and succeeding portions of the slug in turn thereto, means on the opposite side of the heating means from the chucks for drawing tube or rod from the heated end of the slug, and means for selectively effecting the release of the gripping means of each of the chucks while maintaining the aligning means in engagement therewith to allow the successive rearrangement of the chucks outward away from the heating means while the slug continues to be aligned by both said chucks.

2. Apparatus for drawing tube or rod from a vitreous slug comprising heating means, spaced chucks to one side of the heating means and movable toward and away therefrom having gripping means comprised of jaws located about a common axis and having aligning means comprising members located about and movable toward said axis and a spring biased body effecting equal movements of the said members toward said axis, means for moving the chucks at corresponding speeds toward the heating means to advance one end and succeeding portions of the slug in turn thereto, means on the opposite side of the heating means from the chucks for drawing tube or rod from the heated end of the slug, and means for moving the jaws of the chucks away from the axis and the slug to release the gripping means thereof and allow the successive rearrangement of said chucks outward from the heating means while the slug continues to be advanced by one or the other of said chucks and to be aligned by both said chucks.

3. Apparatus for drawing tube or rod from a vitreous slug comprising heating means, spaced chucks to one side of the heating means and movable toward and away therefrom having separate releasable means for gripping and means for aligning a slug therewith, a rotatable shaft located along the course of movement of the chucks, means on each chuck for engaging the shaft to move said chucks at corresponding speeds toward the heating means to advance one end and succeeding portions of the slug in turn thereto comprising a clutch, means on the opposite side of the heating means from the chucks for drawing tube or rod from the heated end of the slug, means for effecting the release of the gripping means of the chucks and means for disengaging the clutches of the chucks to allow the successive rearrangement thereof outward away from the heating means while the slug continues to be advanced by one or the other of said chucks and to be aligned by both said chucks.

4. Apparatus for drawing tube or rod from a vitreous slug comprising heating means, spaced chucks to one side of the heating means and movable toward and away therefrom having separate releasable means for gripping and means for aligning a slug therewith, a rotating feed screw located along the course of movement of the chucks, clutch means on each chuck comprising a threaded member movable to and from engagement with the feed screw for causing movement in said chucks toward the heating means in accord with the lead of the threads thereof to advance one end and succeeding portions of the slug in turn to said heating means, means on the opposite side of the heating means from the chucks for drawing tube or rod from the heated end of the slug, means for effecting the release of the gripping means of the chucks and means for disengaging the threaded member of the clutches of the chucks from the feed screw to allow the successive rearrangement thereof outward away from the heating means while the slug continues to be advanced by one or the other of said chucks and to be aligned by both said chucks.

5. Apparatus for drawing tube or rod from a vitreous slug comprising heating means comprising a hollow core, burners mounted upon one end portion of the core directing flames inward toward an operative position along a drawing axis extending therethrough, a sleeve surrounding and attached to the opposite end portion of the core having longitudinal passages therein for conducting combustible gases, support means engaging the periphery of the sleeve and adapted to permit the rotation of said sleeve and the burners about the drawing axis, means for conducting combustible gases between the adjacent ends of the passages in the sleeve and the burners and fixed means engaging the end of the sleeve opposite the burners and providing circular channels along the course of movement of the ends of the passages in said sleeve for supplying combustible gas to said passages at all rotative positions of the sleeve, means located to one side of the heating means for advancing one end and successive portions of a slug to the operative position to effect the heating thereof, means for rotating the core of the heating means to cause the flames from the burners to impinge uniformly on the full periphery of the slug and means on the opposite side of the heating means from the slug-supporting means for drawing tube or rod from the heated end of the slug.

6. Apparatus for drawing tube or rod from a vitreous slug comprising heating means comprising a hollow burner assembly directing flames inward toward an operative position along a drawing axis extending therethrough and having an end surface substantially perpendicular to said axis with passages terminating therein for receiving the combustible gases, stationary means adjacent the aforementioned end surface of the hollow burner assembly having supply passages for the combustible gas terminating therein and a graphite sealing ring engaging opposite faces of the end surface of the burner assembly and the stationary means having a circular channel in one face thereof concentric with the drawing axis and having connecting passages between said channel and the opposite face for conducting the combustible gas therebetween, means located to one side of the heating means for advancing one end and successive portions of a slug to the operative position to effect the heating thereof, means for rotating the core of the heating means to cause the flames from the burners to impinge uniformly on the full periphery of the slug and means on the opposite side of the heating means from the slug-supporting means for drawing tube or rod from the heated end of the slug.

7. Apparatus for drawing tube or rod from cylindrical quartz slugs comprising a rotatable burner having jet openings directed generally radially inward toward an axis, support means in-

cluding means for gripping said slug about its periphery and holding it against rotation in said axis, means for moving said support means rectilinearly toward said burner to feed the slug axially thereto, means for rotating said burner to uniformly heat a relatively narrow annular zone at the forward end of the slug, means for drawing tube or rod from the heated end of the slug, means for supporting and feeding an additional slug in alignment with the first-mentioned slug, and additional burner means for sealing an end of said additional slug to the end of said first-mentioned slug opposite its said heated end, and means for moving said additional burner means in synchronism with said support means to maintain said additional burner means adjacent the said ends of said first-mentioned and additional slugs to effect fusion thereof during their travel.

8. Apparatus for drawing tube or rod from a vitreous slug comprising heating means comprising a hollow core, a plurality of burners mounted upon one end portion of the core to direct flames inwardly toward an operative position along a drawing axis extending therethrough, a sleeve surrounding and attached to the opposite end portion of said core and having therein pairs of longitudinal passages corresponding to the several burners, support means engaging the periphery of said sleeve and adapted to permit the rotation of said sleeve and the burners about the drawing axis, pairs of conduits connecting each said pair of passages with one of said burners, fixed means engaging the end of said sleeve opposite the burners and providing a pair of concentric circular channels, said longitudinal channels being arranged to communicate with said circular



channels in all rotative positions of said sleeve with one channel of each said pair of longitudinal channels communicating with a different one of said circular channels, and means to supply a combustible gas and a combustion-supporting gas to respective ones of said circular channels for separate transmission through said channels and conduits to said burners, means located to one side of the heating means for advancing a slug rectilinearly to the said operative position to effect the heating of an end thereof, means for rotating the core of the said heating means to cause the flames from the burners to impinge uniformly on the full periphery of the slug, and means on the opposite side of the heating means from the slug-supporting means for drawing tube or rod from the heated end of the slug.

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