Aug. 15, 1950 E. NILES 2,518,924

STEM MAKING METHOD AND APPARATUS

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Fig. 1

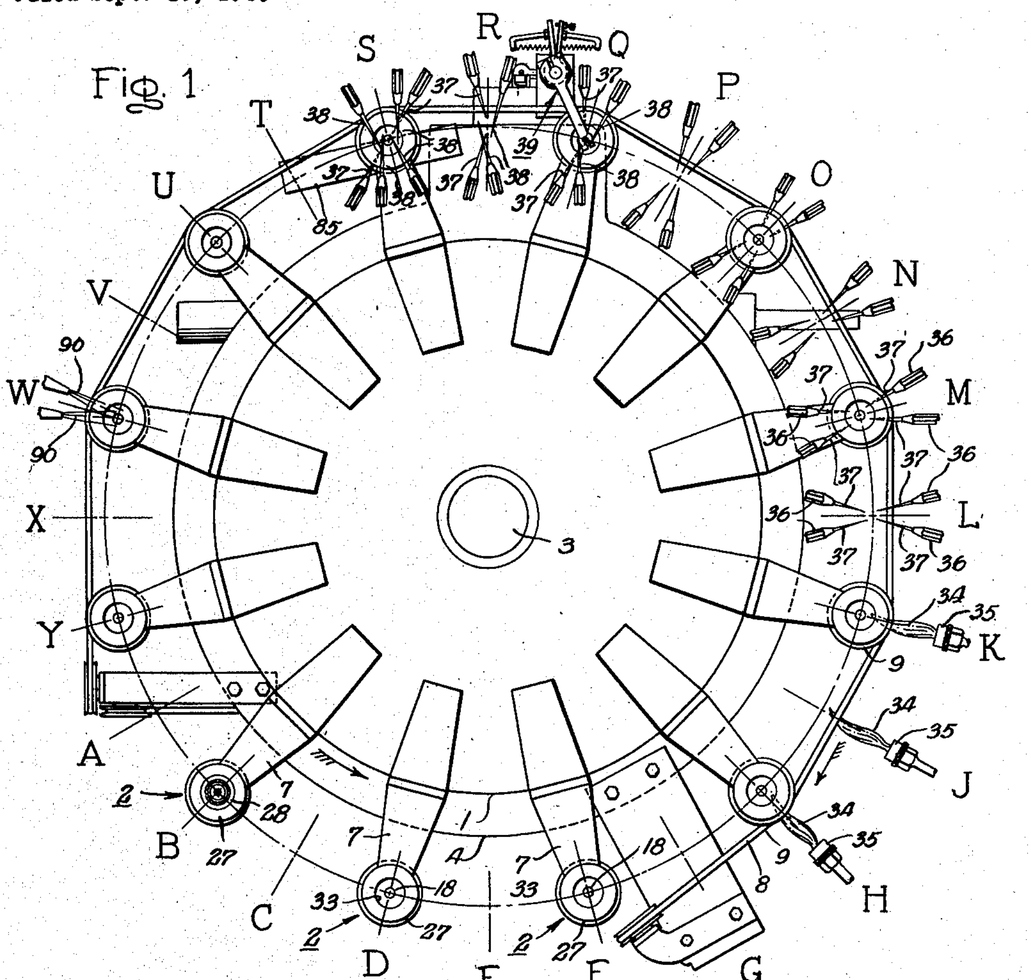
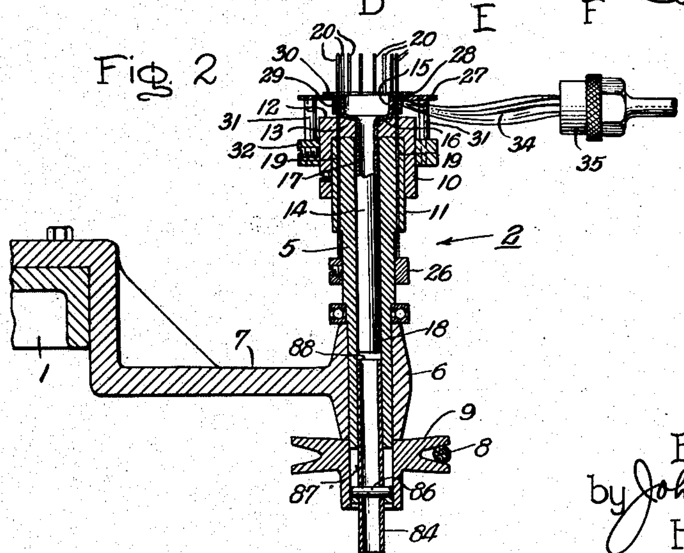


Fig. 2



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Aug. 15, 1950 E. NILES **2,518,924**

STEM MAKING METHOD AND APPARATUS

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Fig. 3

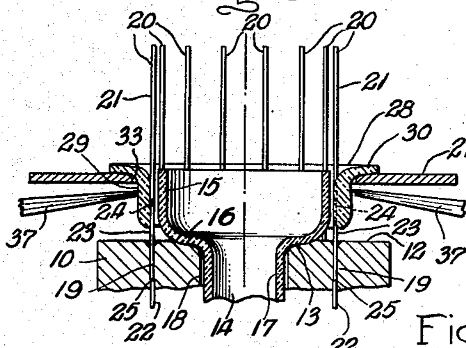


Fig. 4

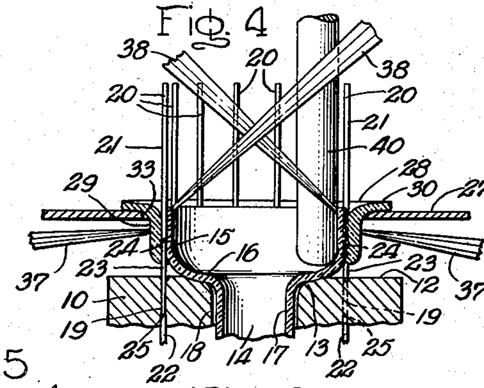


Fig. 5

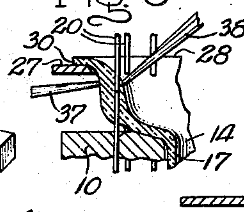


Fig. 6

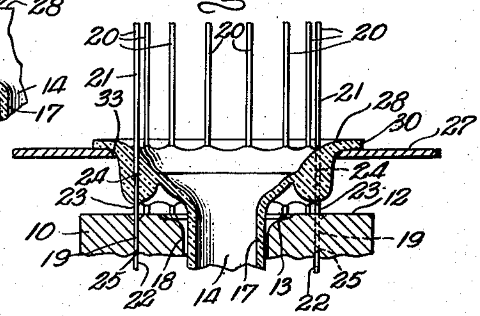


Fig. 7

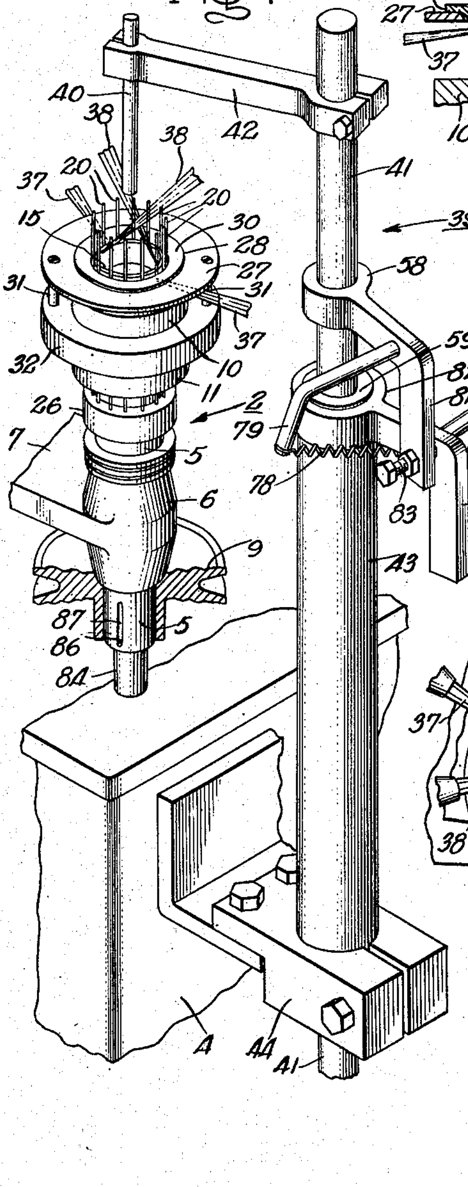
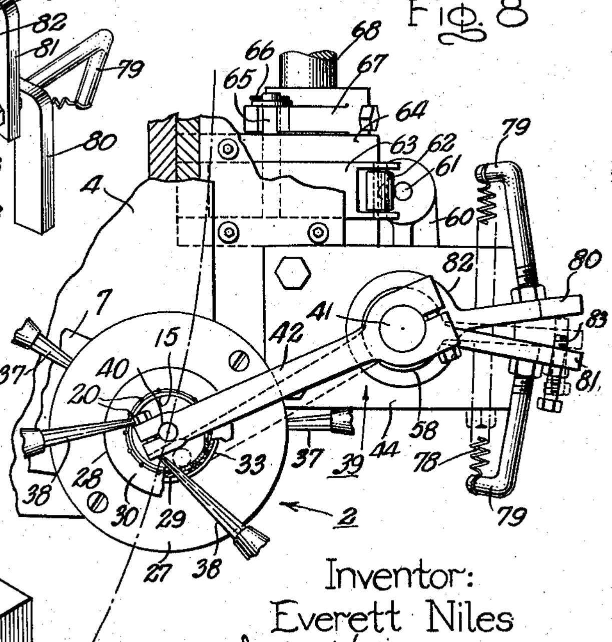


Fig. 8



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STEM MAKING METHOD AND APPARATUS

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Fig. 9

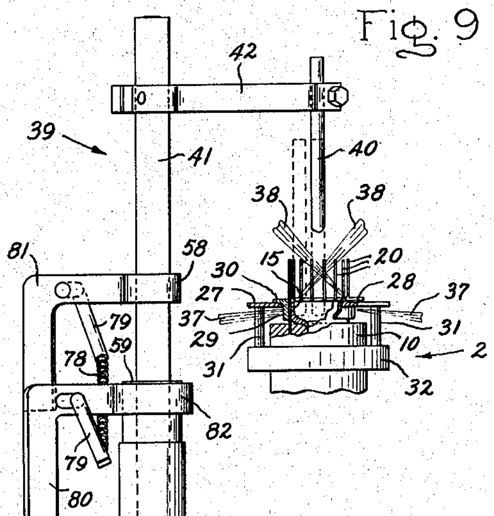
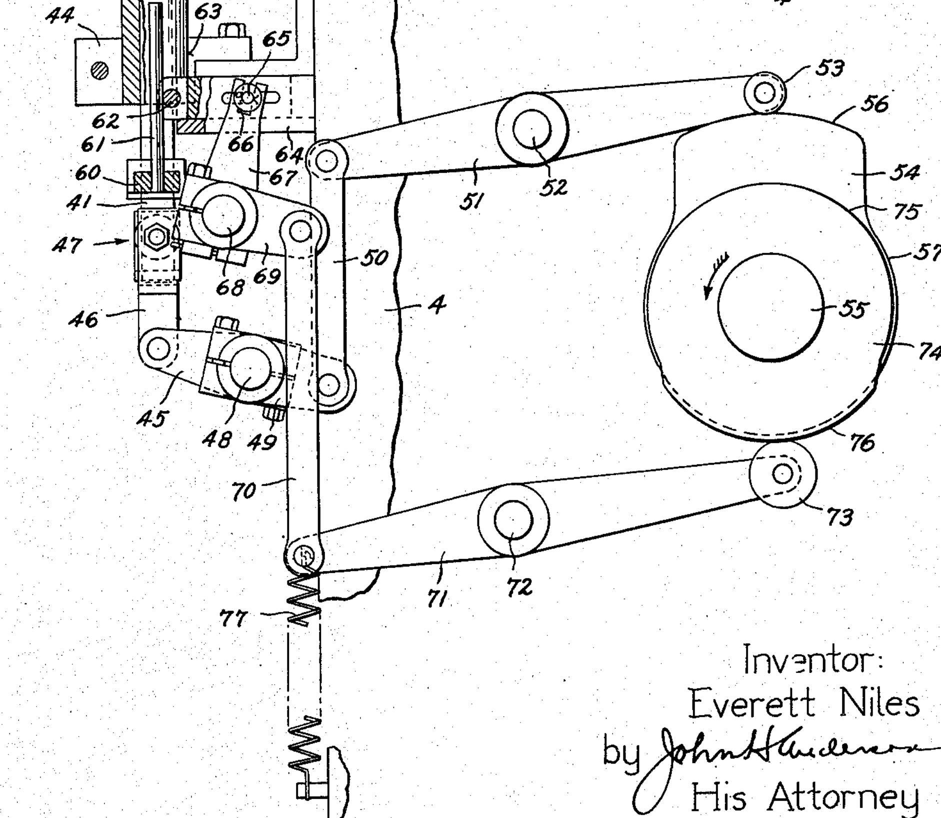
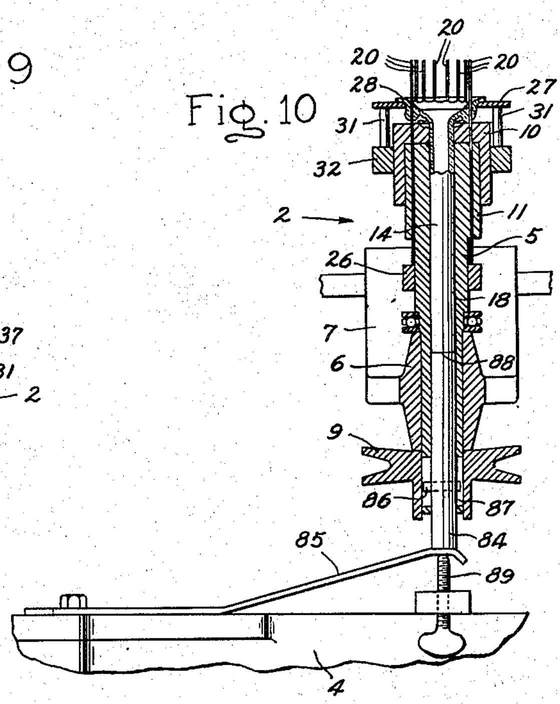



Fig. 10



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Aug. 15, 1950 E. NILES 2,518,924

STEM MAKING METHOD AND APPARATUS

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Fig. 11

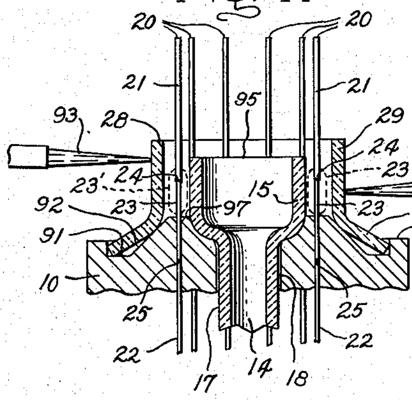


Fig. 12.

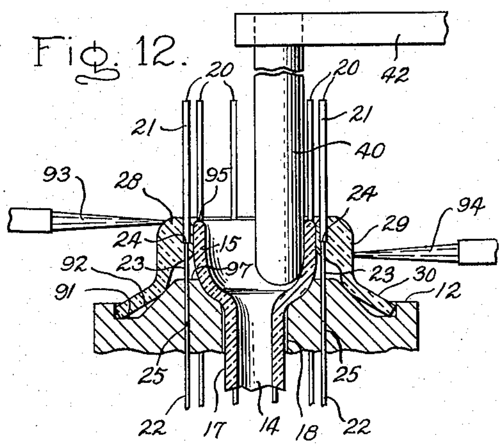


Fig. 13

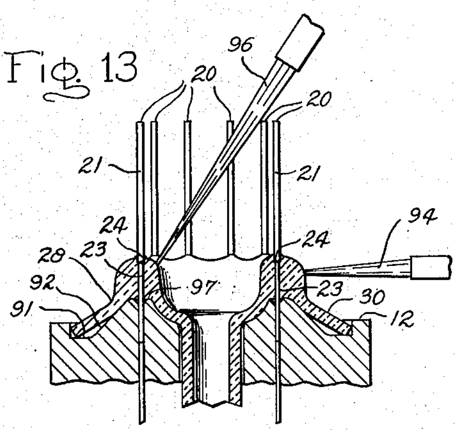


Fig. 14.

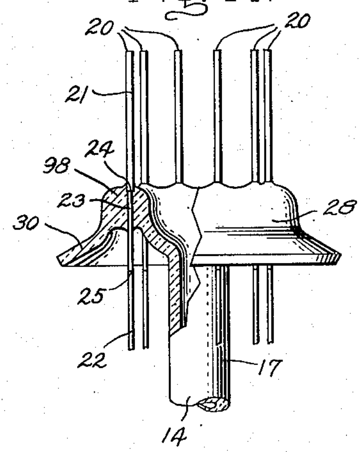
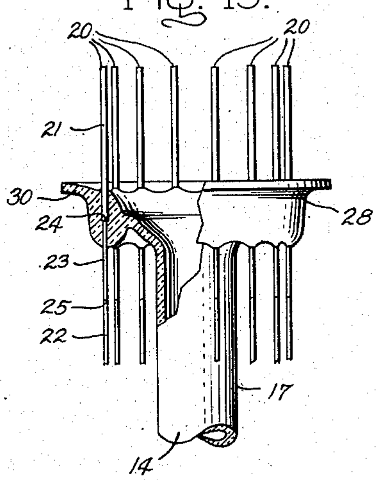


Fig. 15.



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Patented Aug. 15, 1950 2,518,924

UNITED STATES PATENT OFFICE

2,518,924

STEM MAKING METHOD AND APPARATUS

Everett Niles, Willoughby, Ohio, assignor to General Electric Company, a corporation of New York

Application September 15, 1944, Serial No. 555,729

11 Claims. (Cl. 49—2)

My invention relates in general to lead-in seals for enclosed electrical devices such as evacuated electronic discharge devices and electric lamps, and more particularly to a method and apparatus for the manufacture of such seals.

The invention is particularly applicable to a lead-in seal of the so-called "ring" type wherein the lead-in wires are sealed in a circular arrangement through a unitary glass stem structure comprising a glass flare centrally joined to an exhaust tabulation.

In the manufacture of electric incandescent lamps and similar electrical devices, it is customary, during the sealing of the stem into the bulb, to "work" the softened glass at the seal, such as by a pull-down movement of the stem, to thereby eliminate sharp angles between the stem and bulb and so facilitate the formation of a substantially strain-free and therefore mechanically strong seal. Such a relative displacement of the stem and bulb is not permissible, however, in the case of certain electrical devices such as cathode ray tubes wherein both the stem and the bulb neck carry separate electrical elements which must be precisely positioned with respect to one another and which must be maintained in such precise relation during the sealing-in operation.

One object of my invention is to provide a method and apparatus for manufacturing a stem for electrical devices which is of relatively short overall height and which will readily seal to the cylindrical neck of a glass bulb without cracking.

Another object is to provide a method of making such seals without mechanically molding the fused joint in which the lead-in wires are sealed.

Another object of my invention is to provide a method and apparatus for manufacturing a stem of the ring-seal type which will readily fusion-seal to the glass neck of a bulb, to form a mechanically strong seal, without the need of displacing the stem and the bulb neck relative to one another during the sealing operation.

Further objects and advantages of my invention will appear from the following description of a species thereof and from the accompanying drawings in which:

Fig. 1 is a diagrammatic plan view of apparatus comprising my invention for manufacturing stems of the ring-seal type, only the head at station B being shown loaded with the various stem parts; Fig. 2 is a vertical section through one of the heads of the said apparatus, the head being shown positioned at the preheating station H with the various stem parts in their as-

sembled sealing position in the head; Figs. 3 to 6 are fragmentary sectional views showing successive steps comprising my improved sealing method; Fig. 7 is a perspective view of the seal-puddling mechanism at station Q and one of the heads positioned thereat; Fig. 8 is a plan view of the said seal-puddling mechanism at station Q; Fig. 9 is an elevation of the seal-puddling mechanism at station Q and the operating means therefor; Fig. 10 is an elevation of the exhaust tube push-up device at station T with a cooperating head shown in section at said station; Figs. 11 to 13 are fragmentary sectional views showing successive steps of a modified sealing method according to my invention; Fig. 14 is an elevation, partly broken away, of the stem produced by the modified method of Figs. 11 to 13; and Fig. 15 is an elevation, partly broken away, of the stem produced by the preferred method of Figs. 3 to 6.

In accordance with the invention, the various stem parts are first assembled in proper sealing relation with the several lead-in wires circularly arranged in a confined annular space between an enlarged or flared wall portion at the upper end of the exhaust tube and the cylindrical wall portion of a glass flare or stem tube which is preferably placed in an inverted position and which concentrically encloses the exhaust tube enlargement. With the stem parts thus positioned, the cylindrical portion of the flare or stem tube is first melted around the lead-in wires. Then the inner glass wall of the assembly (i. e., the enlarged upper end portion of the exhaust tube), which has been heated to the softening point by radiation of heat from the flare tube or by additional heating means such as gas fires directed thereagainst, is then expanded radially outward against the lead-in wires and into adhering contact with the plastic flare wall by means of a suitable puddling tool. The joint thus formed is then thoroughly heated to form a solid mass of molten glass. Thereafter, in accordance with my preferred process, a slight upward movement is imparted to the exhaust tube to work and redistribute the glass at the inner side of the seal and produce a comparatively large mass of glass at the inner side of the lead-in wires which completely imbeds the upper weld knots of the said wires to a considerable depth.

Referring to the drawings, the apparatus according to the invention comprises a turret or carrier member 1 provided with a plurality (12 in this case) of heads 2 located at uniformly spaced intervals around the periphery of the turret. The turret 1 is supported on a vertical shaft

3 journalled in the machine bed 4 and is intermittently rotated in a counterclockwise direction to successively index or advance the heads 2 to each of a plurality (24 in this case) of work stations A to Y. The indexing means for the turret 1 may be of any well known type, such as that illustrated and described in U. S. Patent 1,742,153, Stiles et al.

Each of the heads 2 comprises a vertically extending hollow spindle 5 journalled in a bearing 6 on a bracket 7 which is fastened to the turret 1 and projects from its periphery. The spindle 5 remains stationary while it is positioned at the loading stations A to F but is rotated at the remaining stations G to Y by means of a moving belt 8 which engages with a pulley 9 fastened to the lower end of the spindle.

At its upper end, the spindle 5 is provided with suitable means for supporting and maintaining the various stem parts in proper sealing relation to one another during the seal-forming operation. For this purpose, the spindle 5 is provided with a cast-iron cap 10 fitting over the spindle head 11 and having its top surface 12 provided with a centrally located seat 13 for supporting a glass exhaust tube 14. The said exhaust tube is formed at one end with an enlarged portion 15 of relatively short length and providing a shoulder 16 which is adapted to rest on the seat 13. Heat is conducted away from the shoulder portion 16 of the exhaust tube through the seat 13 during the sealing operations so that the said shoulder portion retains its shape. The exhaust tube 14 is positioned in the spindle with its enlarged end 15 uppermost and with its remainder or stem portion 17 extending down into the hollow interior or bore 18 of the spindle 5, the said bore 18 being just large enough to freely receive the said stem portion of the exhaust tube while centering it in the spindle.

The cap 10 and the spindle head 11 are further provided with a circularly arranged group of vertically extending holes 19 for receiving and vertically positioning a desired number of lead-in wires 20 at spaced points around and immediately outward of the enlarged upper end 15 of the exhaust tube 14. In the particular case illustrated, fourteen of such lead-in wires 20 are shown, each of said wires comprising a three-part lead consisting of inner and outer leads 21, 22 (Fig. 3) butt-welded to an intermediate press or seal lead 23, as indicated at 24 and 25 respectively. If desired, the lead-in wires 20 may be provided with glass coatings or beads 23' fused to and around the seal lead portions 23 and the upper weld knots 24 of the wires, as shown in dotted lines in Fig. 11. The lead-in wires 20 are supported in proper vertical position relative to the enlarged upper end 15 of the exhaust tube, with the upper or inner weld knots 24 of the wires located alongside the said exhaust tube enlargement 15, by means of a stop or positioning collar 26 which is fastened to the spindle 5 below the spindle head 11 and is vertically adjustable on the spindle. The lead-in wires 20 are inserted and moved down through the holes 19 in the spindle cap 10 and head 11 until their lower ends project out beyond the lower ends of the holes 19 in the spindle head 11 and engage the stop collar 26.

Positioned a short distance above the spindle cap 10 and vertically aligned with the spindle 5 is a cast iron plate or ring 27 for positioning and supporting a glass flare or stem tube 28 concentric with the enlarged upper end 15 of the exhaust tube 14. The said flare 28 consists of a short cylindrical neck or collar portion 29 approximating the length of the enlarged upper end 15 of the exhaust tube 14 and having a flange 30 extending outwardly from one end thereof. The neck portion 29 of the flare 28 is just large enough in diameter to fit over and closely surround the circularly arranged group of lead-in wires 20 positioned in the spindle holes 19. The flare support ring 27 is fastened to and supported by a pair of diametrically opposite posts 31 fastened to a collar 32 which is secured to, but vertically adjustable on the spindle cap 10. The flare support ring 27 is provided with a central opening 33 concentric with the spindle bore 18 and the circularly arranged group of lead-in wire holes 19, and just large enough to receive the neck portion 29 of the flare 28 so as to center it on the spindle. The flare 28 is positioned in an inverted position on the support ring 27 with its flanged end uppermost and the flange 30 resting on the ring. The vertical position of the flare support ring 27 relative to the spindle cap 10 is so fixed, by proper adjustment of the collar 32 on the spindle cap 10, as to position the neck portion 29 of the flare directly opposite or alongside the enlarged upper end 15 of the exhaust tube so as to surround the said tube end portion. In the case of large size flares 28, for instance those having an internal diameter of around one inch or more, it is desirable to keep the lower end of the flare neck 29 up off the spindle cap 10, as shown, since with these parts in contact the flare might crack because of excessive conduction of heat away from the flare by the cap 10.

In the operation of the apparatus according to the invention, the various stem parts, comprising the exhaust tube 14, the lead-in wires 20 and the flare 28, are loaded into their proper sealing position in the head 2 (as shown in Fig. 2) while the head is positioned at the loading stations A to F, the complete loading of the head usually being performed at stations A and B. The loaded head 2 is then carried by the turret 1 to idle station G where the spindle pulley 9 engages the moving belt 8 to initiate rotation of the spindle 5.

From idle station G the head 2 is then successively indexed in turn to each of three preheating stations H, J and K where soft gas fires 34 from burners 35 located at said stations are directed against the cylindrical portion 29 of the glass flare 28 (as shown in Fig. 2) to preheat the flare and so prevent it from cracking.

Following the preheating of the glass flare 28 at stations H, J, and K, the head 2 is then successively indexed to each of five similar sealing-fire stations L to P inclusive at each of which is located two diametrically opposite pairs of gas burners 36 which direct hard pin-point gas fires 37 (Fig. 3) horizontally against the neck portion 29 of the flare 28. These fires 37 cause the glass of the flare neck 29 to gradually become molten and to gather up around the lead-in wires 20 in the manner shown in Fig. 3. At the same time, the enlarged upper end 15 of the exhaust tube 14 receives enough heat by radiation from the fused flare neck 29 to become plastic and capable of deformation.

From station P, the head 2 is next indexed to the glass puddling station Q where the enlarged upper end 15 of the exhaust tube is preferably further heated by a pair of opposed sharp-pointed gas fires 38 (Fig. 4) directed downwardly at an angle against the said uppper end of the exhaust tube, the glass of the flare neck 29 meanwhile being maintained in its molten condition by a pair of opposed gas fires 37 similar to those at the preceding stations L to P. The fires 38 are angled downwardly at a sufficient angle to clear the upper ends of the lead-in wires 20.

During the dwell of the head 2 at station Q, the plastic upper end 15 of the exhaust tube is expanded horizontally outward against the lead-in wires 20 and into intimate contact with the molten glass of the flare neck 29 by means of a suitable puddling device 39 located at said station. In accordance with the invention, the said puddling device 39 comprises a vertically disposed puddling rod 40 (Figs. 7-9) which is first lowered into the enlarged upper end 15 of the rotating exhaust tube 14 and is then moved laterally into outward pressure engagement with the said upper end of the exhaust tube, as shown in Fig. 4. The continued rotation of the exhaust tube 14, while the rod 40 is thus pressed outwardly against the plastic wall 15 of the exhaust tube, thus causes the said wall to be pressed outwardly progressively around its entire circumference so as to imbed the lead-in wires 20 and stick to the molten neck 29 of the flare 28. The puddling rod 40 is made of a suitable material, such as brass or carbon, which will not permanently adhere to the softened glass, and the gas fires 38 are located on opposite sides of the rod so as not to impinge thereagainst.

The horizontal and vertical movements of the puddling rod 40 may be automatically effected by means of a vertically extending operating rod 41 to the upper end of which is fastened a horizontal arm 42 which carries the puddling rod 40 in a position directly over the spindle 5 of the head 2 at station Q. The operating rod 41 is supported in a sleeve bearing 43 which is fastened to a bracket 44 secured to the bed 4 of the machine.

For effecting the vertical movements of the puddling rod 40, the lower end of the operating rod 41 is connected to a more or less horizontally extending arm 45 (Fig. 9) through a vertical link 46 having both a pivotal and swivel connection 47 with the operating rod. The arm 45 is fastened on a horizontal shaft 48 supported in a bearing (not shown) mounted on the machine bed. Another arm 49 fastened to the said shaft 48 and extending therefrom in a direction more or less opposite to the arm 45, is connected by a vertical link 50 to one end of a rocker arm 51 pivotally mounted on a stud shaft 52. The other end of the rocker arm 51 carries a roller 53 which rides on the periphery of a disc cam 54 mounted on the main drive shaft 55 of the machine. The cam 54 is formed with an elevated portion 56 and a depressed portion 57. The elevated portion 56 of the cam 54 lifts and holds the puddling rod 40 in its elevated or inoperative position (as shown in full lines in Fig. 9) just before and during the index movement of the turret 1 so that the said rod 40 is up out of the path of movement of the lead-in wires 20 and the other parts of the stem assembly as the latter is indexed to and away from station Q. The depressed portion 57 of the cam 54 allows the operating rod 41, arm 42 and puddling rod 40 to move down, of their own weight, to the lower or operative position of the puddling rod (as shown in dotted lines in Fig. 9) as soon as a head 2 reaches station Q and while it is positioned thereat. The lowered position of the puddling rod 40 is determined by the engagement of an adjustable stop collar 58 on the operating rod 41 with the upper end 59 of the sleeve bearing 43.

For effecting the horizontal movements of the puddling rod 40 into and out of pressure engagement with the plastic side wall of the exhaust tube enlargement 15, the operating rod 41 is provided with a horizontally extending arm or bracket 60 carrying an upstanding finger or pin 61. The pin 61 is engaged by a roller 62 carried by a horizontally reciprocable slide 63 to thereby move the pin and thus rotate the operating rod 41 clockwise (as viewed in Fig. 8) so as to move the puddling rod 40 laterally out of engagement with the enlarged upper end 15 of the exhaust tube and return it to its normal position more or less centered with respect to the spindle 5, as shown in full lines in Figs. 8 and 9. The slide 63 is slidably mounted in a guide block 64 secured to the machine bed 4, and it carries a pin 65 which is received within the space 66 between the two arms at the bifurcated end of a lever arm 67 which is fastened to a horizontal shaft 68 supported on the machine bed 4. The shaft 68 carries another arm 69 which is connected by a vertical link 70 to one end of a rocker arm 71 pivotally mounted on a stud shaft 72. The other end of the rocker arm 71 carries a roller 73 which rides on the periphery of a disc cam 74 mounted on the main drive shaft 55 and provided with a depressed portion 75 and a slightly elevated portion 76. The elevated portion 76 of the cam effects the return movement of the puddling rod 40 to its inoperative or centered postion relative to the spindle 5 just before the said rod 40 is raised to its elevated position by the cam 54. The depressed portion 75 of the cam 74 allows the puddling rod 40 to be moved laterally from its centered postion into outward pressure engagement with the plastic upper end 15 of the exhaust tube just after the said rod 40 moves down to its lowered position following the arrival of a head 2 at station Q. The depressed portion 75 of cam 74 permits the roller 62 on slide 63 to be withdrawn or moved laterally away from the pin 61 by the action of a tension coil spring 77 connected between the rocker arm 71 and the bed or other stationary part of the machine. Upon such withdrawal of the roller 62 away from the pin 61, the operating rod 41 is then free to rotate counterclockwise (Fig. 8) so as to swing the puddling rod 40 laterally from its centered position into engagement with the plastic upper end 15 of the exhaust tube. The slight counterclockwise rotational movement of the operating rod 41 necessary to move the puddling rod 40 against the exhaust tube wall portion 15 is effected by the action of a more or less horizontally disposed tension coil spring 78 which is connected between posts 79 extending from two arms 80 and 81 one of which (arm 80) is fastened to a collar 82 secured to the upper end of the sleeve bearing 43 and the other one of which (arm 81) is fastened to the stop collar 58 on the operating rod 41. The two arms 80, 81 are more or less side-by-side one another when the puddling rod 40 is in its lowermost position. Arm 81, which swings with the rotating movements of the operating rod 41, is provided with a stop screw or pin 83 which is adapted to engage the other or stationary arm 80 to thereby limit the extent of lateral movement of the puddling rod 40 away from its normal centered position by the spring 78 and so determine the amount of expansion of the plastic upper end wall 15 of the exhaust tube by the puddling rod.

Following the glass puddling operation at station Q, the head 2 is successively indexed to stations R and S where sharp-pointed fires 37 and 38, like those at station Q, heat the flare neck 29 and the upper enlarged end 15 of the exhaust tube into a solid mass of molten glass as shown in Fig. 5. If desired, the stem may be considered completed at this stage and may be used in the form shown in said Fig. 5. However, I prefer to further work the seal and modify its shape to that shown in Figs. 6 and 15.

The form of seal shown in Figs. 6 and 15 is obtained by moving the exhaust tube 14 upward a slight distance relative to the flare 28, during the index of head 2 to the next station T, to "work" and redistribute the molten glass at the inner side of the seal. This "push up" of the exhaust tube assures the presence of a comparatively large amount of glass at the inner side of the lead-in wires 20 and completely imbedding the upper weld knots 24 thereof to a considerable depth, such a glass distribution enhancing the formation of a strong and hermetically tight seal.

The "push up" of the exhaust tube 14, during the index of the head 2 from stations S to T, may be conveniently produced by a push rod 84 which is reciprocably mounted in the bore 18 of the spindle 5 and which engages with an inclined cam track 85 (Figs. 1 and 10) mounted on the bed 4 of the machine. The push rod 84 is provided with a transversely extending pin 86 which projects into, and normally rests on the bottom of a vertically elongated slot 87 in the spindle 5 to thereby support the push rod in the spindle. The upper end 88 of the push rod 84 is normally spaced a slight distance below the lower end of the exhaust tube 14, as shown in Fig. 2.

During the index of the head 2 from stations S to T, the push rod 84 rides up the inclined cam track 85, thus engaging the lower end of the exhaust tube 14 and pushing it up the desired amount as determined by the setting of an adjustment screw 89 which is adapted to control the elevation of the cam track 85. During such upward movement of the exhaust tube 14, the glass flare 28 remains in its original position down on the flare support ring 27, rather than being lifted up off the ring by the exhaust tube, by reason of the fact that the hot flange portion 30 of the flare 28 sticks to a slight degree to the cast iron flare support ring 27.

Following the glass "working" and redistributing operations at station T, the head 2 is then indexed in turn through the remaining idle stations U to X, inclusive, where the completed seal is allowed to cool in the surrounding atmosphere so as to permit its removal from the head 2 by an operator at the unloading station Y. During the cooling of the completed stem, the difference in the cooling and contraction rates of the glass and the cast iron flare support ring 27 ordinarily causes the glass flange portion 30 of the completed stem, which theretofore had been stuck to the said ring, to break away from the ring 27 and thus free the stem for removal from the head. However, in the case of smaller size seals, such as those having a flare neck diameter of less than one inch or so, it may be necessary to accelerate the cooling of the glass stem, as by air jets 90 directed thereagainst at one or more of the cooling stations U to X (preferably station W), in order to separate the glass flange 30 of the stem from the metal support ring 27.

In the modified seal-forming method illustrated in Figs. 11 to 13, the glass flare or stem tube 28 is mounted on the spindle 5 in a position the reverse from that which it occupies in the previously described method, i. e., with its flange 30 lowermost and resting on the upper surface 12 of the spindle cap 10. For this purpose, the upper surface 12 of the spindle cap 10 is formed with an annular recess 91 for receiving the flange 30 of the flare or stem tube 28 and centering the latter on the spindle 5. The said upper surface 12 is also provided with a raised frusto-conical seat 92 for engaging the underside of the stem tube flange 30 to further support and center the stem tube 28 on the spindle.

With the exhaust tube 14, lead-in wires 20 and flare or stem tube 28 mounted in proper sealing relation on the rotatable spindle 5 in the manner shown in Fig. 11, the cylindrical wall or neck portion 29 of the flare or stem tube 28 is first preheated by directing thereagainst a soft gas fire like the fire 34 shown in Fig. 2. Thereafter, the said neck portion 29 of the rotating flare 28 is subjected to intensive heating by a pair of hard pin-point sealing fires 93, 94 to thereby melt the said neck portion 29 down and around the lead-in wires 20 in the manner illustrated in Fig. 12. Gas fire 93 is directed approximately horizontally against the upper region of the cylindrical flare neck 29 while gas fire 94 is directed approximately horizontally against the lower region of the said flare neck at the zone where the seal is ultimately formed as shown in Fig. 13. During the heating and fusion of the flare neck 29 by the gas fires 93, 94, the heat radiated by the fused glass of the flare 28 serves to heat the enlarged upper end 15 of the exhaust tube sufficiently to soften it so as to be capable of deformation.

When the heating and fusion of the flare 28 has progressed to the point where the upper end of the flare neck 29 has melted down approximately to the level of the upper end or rim 95 of the exhaust tube 14 as shown in Fig. 12, the puddling rod 40 is inserted within the enlarged upper end of the exhaust tube and is then moved laterally into outward pressure engagement with the plastic enlarged wall portion 15 of the rotating exhaust tube to thereby expand and press the said wall portion 15, progressively around its entire circumference, against the lead-in wires 20 and into adhering contact with the fused neck 29 of the flare 28. The puddling rod 40 is held against the plastic wall 15 of the exhaust tube during at least one complete revolution of the spindle 5 so as to expand the said wall 15 completely around its full circular extent.

After the enlarged upper end 15 of the exhaust tube has been thus joined with the fused flare neck 29 so as to imbed the lead-in wires 20, the glass around the said wires is then further heated by gas fires 94 and 96 until it becomes a solid molten mass and sags down onto the flat top 97 of the frusto-conical flare seat 92, as shown in Fig. 13. The gas fire 94 heats the glass at the outer side of the lead-in wires 20 while the gas fire 96 is directed against the glass at the inner side of the said wires. As shown, the fire 96 is preferably directed downwardly at a relatively steep angle so as to clear the upper ends of the lead-in wires 20.

When the fused glass around the lead-in wires 20 has thus sagged down onto the top 97 of the flare seat 92, the heating of the glass is discontinued and the stem allowed to cool, after which it may be removed from the head 2. As shown in Fig. 14, the completed seal thus formed is characterized by a relatively thick band of glass 98 which imbeds the press leads 23 and upper weld knots 24 to a considerable depth, thus providing a very strong and hermetically tight seal.

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

1. The method of making stems for sealed electrical devices which comprises assembling a glass flare tube concentrically around an enlarged tubular end of a glass exhaust tube with a plurality of lead-in wires extending longitudinally between the flare tube and the enlarged end of the exhaust tube, fusing a portion of the flare tube around the lead-in wires and heating the said end of the exhaust tube to a plastic condition, expanding the plastic exhaust tube end against the leading-in wires and into contact with the fused portion of the flare by applying pressure laterally outward against a limited area of the inner wall of the said tube end and thence progressively around the periphery of said wall, fusing together the flare tube and the said exhaust tube end into a solid molten mass, and then displacing the exhaust tube a small distance longitudinally inward of the flare while the said mass is still plastic to redistribute and thicken the glass at the inner side of the seal.

2. The method of making stems for sealed electrical devices which comprises assembling a glass flare tube concentrically around an enlarged tubular end of a glass exhaust tube with a plurality of lead-in wires extending longitudinally between the flare tube and the enlarged end of the exhaust tube, fusing a portion of the flare tube around the lead-in wires and heating the said end of the exhaust tube to a plastic condition, pressing a tool laterally outward against the inner wall of the said exhaust tube end to expand the said end and press it against the lead-in wires and the flare tube while the latter is in a fused condition, fusing together the flare tube and the said exhaust tube end into a solid molten mass, and then displacing the exhaust tube a small distance longitudinally inward of the flare while the said mass is still plastic to redistribute and thicken the glass at the inner side of the seal.

3. The method of making stems for sealed electrical devices which comprises assembling a glass flare tube concentrically around an enlarged tubular end of a glass exhaust tube with a plurality of glass-beaded lead-in wires extending longitudinally through the annular space between the flare tube and the enlarged end of the exhaust tube and having their glass beads located within the said space, fusing a portion of the flare tube around the lead-in wires and the glass beads thereon and heating the said end of the exhaust tube to a plastic condition, expanding the said exhaust tube end against the lead-in wires and the glass beads thereon and against the flare tube while the said glass beads and flare tube are in a fused condition, fusing together the flare tube, the glass beads and the said exhaust tube end into a solid molten mass, and then displacing the exhaust tube a small distance longitudinally inward of the flare tube while the said mass is still plastic to redistribute and thicken the glass at the inner side of the seal.

4. Apparatus for making stems of the ring-seal type comprising a head having means for supporting a stem assembly comprising a glass flare tube, glass exhaust tube and a plurality of lead-in wires in sealing relation with the flare tube concentrically surrounding an end of the exhaust tube and the lead-in wires extending longitudinally between said tubes through the annular space therebetween, means located adjacent said head for fusing the flare tube and the said end of the exhaust tube, means for expanding the plastic end of the exhaust tube to press it against the lead-in wires and the fused flare tube, and means for subsequently moving the exhaust tube a small amount longitudinally inward of the flare tube to work and redistribute the glass at the inner side of the seal.

5. Apparatus for making stems of the ring-seal type comprising a head having means for supporting a stem assembly comprising a glass flare tube, glass exhaust tube and a plurality of lead-in wires in sealing relation with the flare tube concentrically surrounding an end of the exhaust tube and the lead-in wires extending longitudinally between said tube through the annular space therebetween, means located adjacent said head for fusing the flare tube and the said end of the exhaust tube, means comprising a puddling rod of smaller diameter than the said end of the exhaust tube and movable laterally within the said end of the exhaust tube to expand it against the lead-in wires and the flare tube, means to effect relative rotary movement between said rod and the stem assembly about the axis of the stem assembly to expand the exhaust tube end around its entire circumference, and means for subsequently moving the exhaust tube a small amount longitudinally inward of the flare tube to work and redistribute the glass at the inner side of the seal.

6. Apparatus for making stems of the ring-seal type comprising a carrier member provided with a plurality of heads each comprising a rotatable spindle arranged to support a stem assembly comprising a glass flare tube, glass exhaust tube and a plurality of lead-in wires in sealing relation with the exhaust tube extending vertically and the flare tube concentrically surrounding the upper end of the exhaust tube and with the lead-in wires extending vertically through the annular space between the said tubes, means for intermittently indexing said carrier member to successively index said heads to a plurality of work stations, means at one of said stations for fusing a portion of the flare tube around the lead-in wires, means at a succeeding station for heating the upper end of the exhaust tube to a plastic condition and expanding it against the lead-in wires and the flare tube, means at a subsequent station for fusing together the flare tube and the upper end of the exhaust tube into a solid molten mass, and means for subsequently moving the exhaust tube upward a small amount to work and redistribute the glass at the inner side of the seal.

7. Apparatus for making stems of the ring-seal type comprising a carrier member provided with a plurality of heads each comprising a rotatable spindle arranged to support a stem assembly comprising a glass flare tube, glass exhaust tube and a plurality of lead-in wires in sealing relation with the exhaust tube extending vertically and the flare tube concentrically surrounding the upper end of the exhaust tube and with the lead-in wires extending vertically through the annular space between the said tubes, means for intermittently indexing said carrier member to successively index said heads to a plurality of work stations, means at one of said stations for fusing the flare tube around the lead-

in wires, means at a succeeding station for heating the upper end of the exhaust tube to a plastic condition, a vertically disposed puddling rod located at said succeeding station in a position out of the path of index movement of the head and the stem assembly mounted thereon, means for first introducing an end of said puddling rod into the upper end of the rotating exhaust tube and then moving the rod laterally against the said exhaust tube end to press it outwardly against the lead-in wires and the fused flare tube during rotation of said spindle, and means at a subsequent station for fusing together the flare tube and the upper end of the exhaust tube into a solid molten mass.

8. Apparatus for making stems of the ring-seal type comprising a carrier member provided with a plurality of heads each comprising a rotatable spindle arranged to support a stem assembly comprising a glass flare tube, glass exhaust tube and a plurality of lead-in wires in sealing relation with the exhaust tube extending vertically and the flare tube concentrically surrounding the upper end of the exhaust tube and with the lead-in wires extending vertically through the annular space between the said tubes, means for intermittently indexing said carrier member to successively index said heads to a plurality of work stations, means at one of stations for fusing the flare tube around the lead-in wires, means at a succeeding station for heating the upper end of the exhaust tube to a plastic condition, a vertically disposed puddling rod located at said succeeding station in a position out of the path of index movement of the head and the stem assembly mounted thereon, means for first introducing an end of said puddling rod into the upper end of the rotating exhaust tube and then moving the rod laterally against the said exhaust tube end to press it outwardly against the lead-in wires and the fused flare tube during rotation of said spindle, means at a subsequent station for fusing together the flare tube and the upper end of the exhaust tube into a solid molten mass, and means for subsequently moving the exhaust tube upward a small amount to work and redistribute the glass at the inner side of the seal.

9. Apparatus for making stems of the ring-seal type comprising a vertically disposed spindle having openings for receiving and vertically supporting a glass exhaust tube and a plurality of lead-in wires in sealing relation with the lead-in wires spaced about and alongside the upper end of the exhaust tube, means carried by the spindle for supporting a glass flare tube concentrically about the upper end of the exhaust tube and around the said lead-in wires with its flared end uppermost, means located adjacent said spindle for heating and fusing the contiguous wall portions of the flare tube and the said exhaust tube, a puddling rod associated with said spindle and movable into and thence laterally within the upper end of the exhaust tube to press the wall thereof laterally outward against the lead-in wires and the flare tube, and means comprising

a push rod vertically movable within said spindle to move the exhaust tube upward and thus effect a working and redistribution of the glass at the inner side of the seal.

10. The method of making stems for sealed electrical devices which comprises assembling a glass flare tube concentrically around an enlarged end of a glass exhaust tube with a plurality of lead-in wires extending longitudinally between said tubes, fusing a portion of the flare tube around the lead-in wires and heating the enlarged end of the exhaust tube to a plastic condition, expanding the said exhaust tube end against the lead-in wires and into contact with the flare tube while the latter is in a fused condition, fusing together the flare tube and the said exhaust tube end into a solid molten mass, and then displacing the exhaust tube a small distance longitudinally inward of the flare to redistribute the glass at the inner side of the seal.

11. The method of making stems for sealed electrical devices which comprises assembling a glass flare tube concentrically around an enlarged upper end of a vertically disposed glass exhaust tube with a plurality of lead-in wires extending vertically through the annular space between said tubes, fusing a portion of the flare tube around the lead-in wires and heating the said enlarged end of the exhaust tube to a plastic condition, expanding the said exhaust tube end against the lead-in wires and into contact with the flare tube while the latter is in a fused condition, fusing together the flare tube and the said exhaust tube end into a solid molten mass, and then displacing the exhaust tube a small distance vertically upward relative to the flare tube to re-distribute the glass at the inner side of the seal.

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