Nov. 10, 1970 G. A. MARLIN ET AL 3,539,323

APPARATUS FOR ASSEMBLING SEALED CONTACT SWITCHES

Filed March 3, 1967 4 Sheets-Sheet 1

FIG. 1.

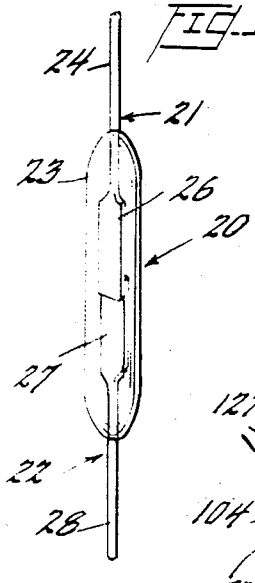
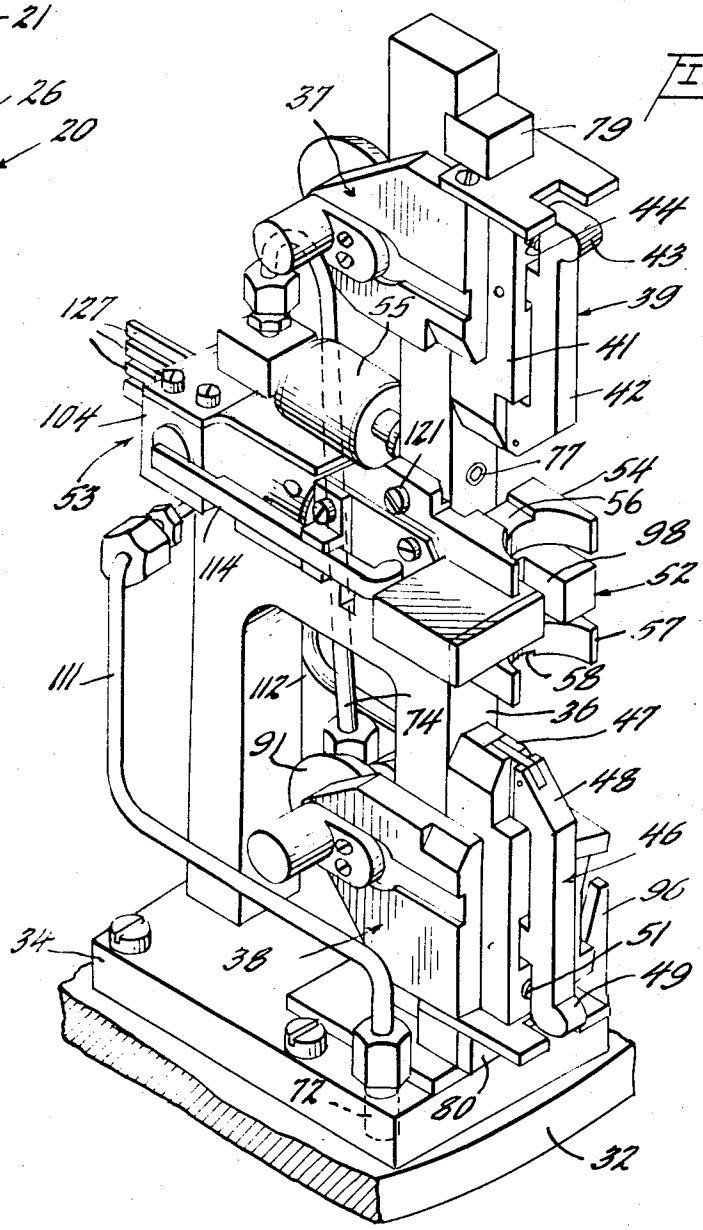


FIG. 3.



Inventors
Glenn A. Marlin
James C. McConnell
Wilhelm E. A. Schmidt,

S. A. Becker

Attorney

Nov. 10, 1970 G. A. MARLIN ET AL 3,539,323

APPARATUS FOR ASSEMBLING SEALED CONTACT SWITCHES

Filed March 3, 1967 4 Sheets-Sheet 2

FIG. 2.

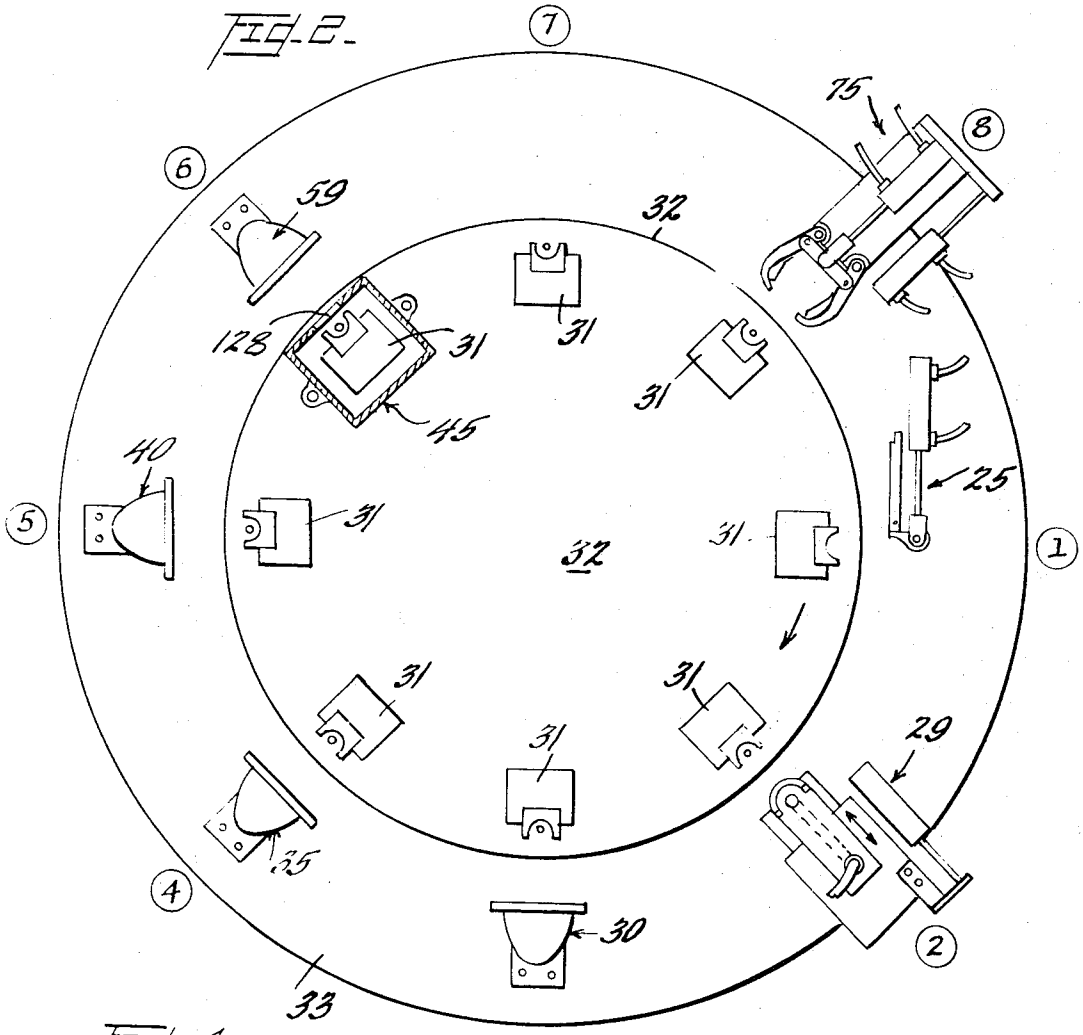


FIG. 4.

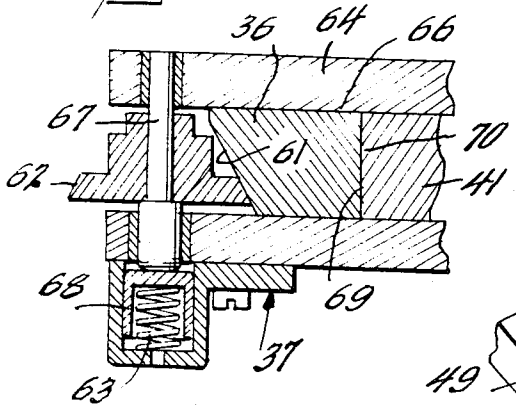
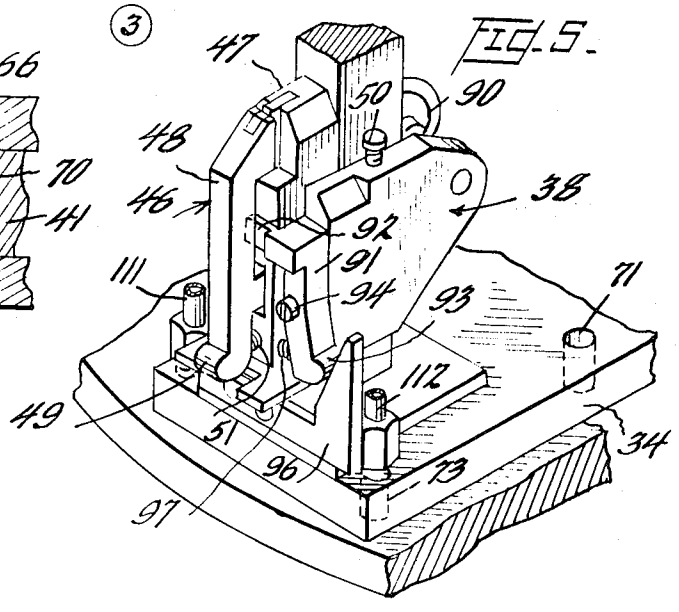


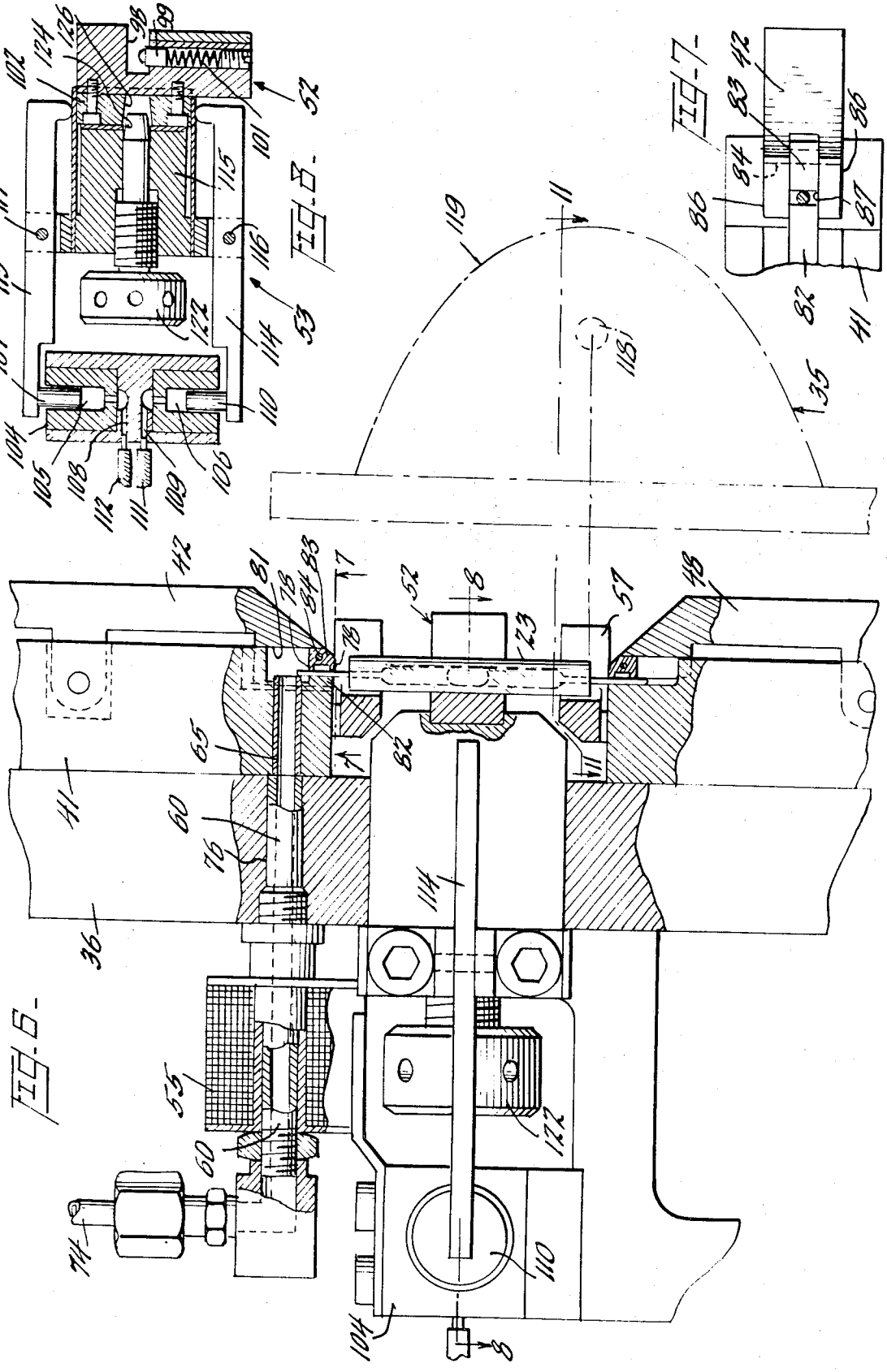
FIG. 5.



Nov. 10, 1970 G. A. MARLIN ET AL 3,539,323

APPARATUS FOR ASSEMBLING SEALED CONTACT SWITCHES

Filed March 3, 1967 4 Sheets-Sheet 3



Nov. 10, 1970 G. A. MARLIN ET AL 3,539,323

APPARATUS FOR ASSEMBLING SEALED CONTACT SWITCHES

Filed March 3, 1967

4 Sheets-Sheet 4

FIG. 11.

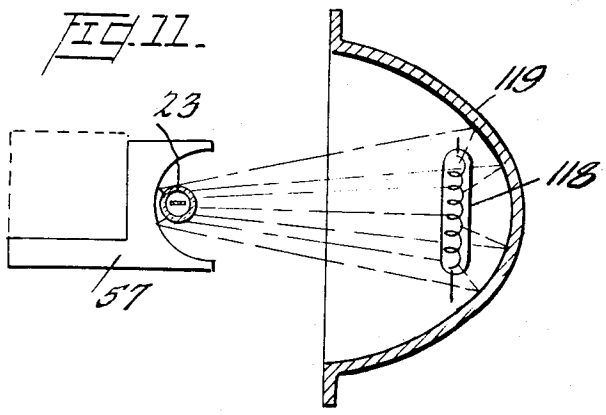


FIG. 9.

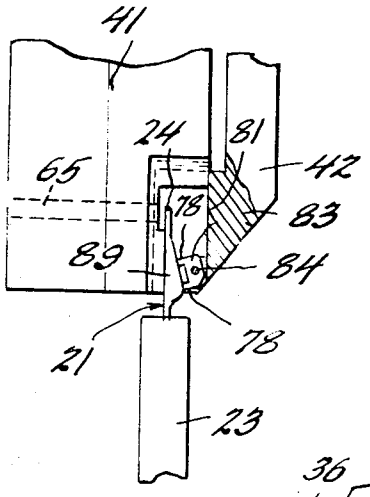


FIG. 10.

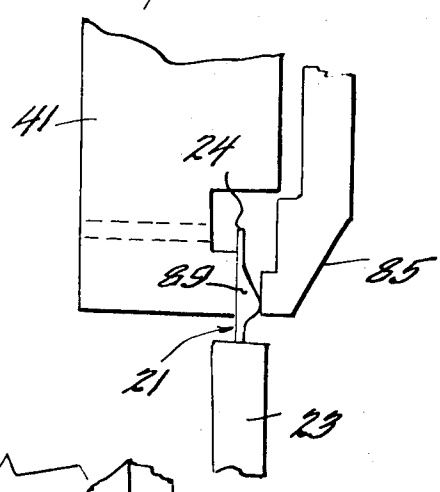
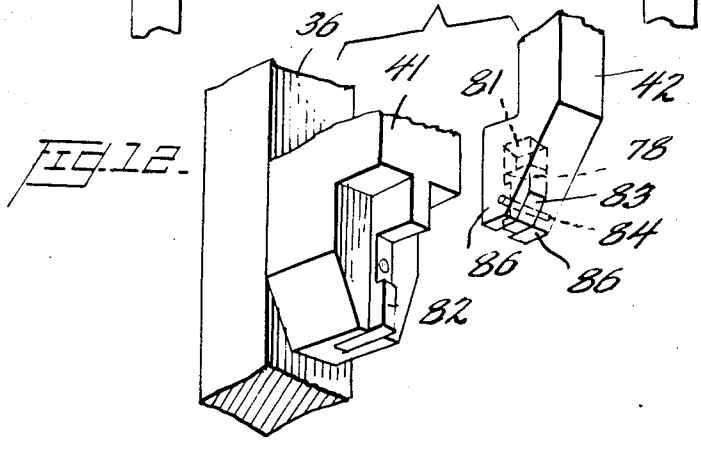


FIG. 12.



United States Patent Office 3,539,323 Patented Nov. 10, 1970

3,539,323

APPARATUS FOR ASSEMBLING SEALED CONTACT SWITCHES

Glenn Adrian Marlin, James Clifford McConnell, and Wilhelm Emil Albert Schmidt, Winston-Salem, N.C., assignors to Western Electric Company, Incorporated, New York, N.Y., a corporation of New York

Filed Mar. 3, 1967, Ser. No. 621,730
Int. Cl. C03c 27/02
U.S. Cl. 65—139 4 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for assembling sealed contact switches having an upper and a lower contact positioned and sealed within a glass sleeve in spaced overlapping relationship. The apparatus holds the upper and the lower contacts and moves them into a glass sleeve after which the upper contact is magnetized to attract the overlapping portion of the lower contact to support and hold the lower contact. The lower contact is then sealed by radiant energy within the lower end of the glass sleeve while a forming gas is introduced into the upper end of the glass sleeve. Subsequently, facilities are actuated to move the glass sleeve and sealed lower contact laterally with respect to the upper contact to set a predetermined gap between the overlapping portions of the upper and lower contacts. Then the upper contact is sealed within the upper end of the glass sleeve in an enclosed pressurized chamber.

CROSS REFERENCE TO RELATED APPLICATION

This application is related to an application, Ser. No. 620,320, filed Mar. 3, 1967, in the names of James C. McConnell, Samuel Pinnolis, and Wilhelm E. A. Schmidt.

BACKGROUND OF THE INVENTION

Assembly machines such as that disclosed in N. F. Gubitose et al. Pat. 3,273,989, are available for making sealed contact switches. However, these machines require the use of rather large, complex, and expensive mechanisms to properly fabricate switches within desired manufacturing tolerances. It is desirable to manufacture such switches using improved apparatus which is smaller, simpler, and less expensive.

An object of this invention is to provide new and improved apparatus for assembling sealed contact switches.

It is a further object of this invention to provide new and improved apparatus for assembling sealed contact switches wherein the sealing is accomplished by utilizing radiant energy.

Another object of this invention is to provide assembly apparatus having new and improved contact magnetizing facilities which are rendered effective by movement of the contacts into the glass sleeve.

A further object of this invention is to provide an assembly fixture having facilities for latching one of its carriages open after magnetization of the contact held therein.

Another object of this invention is to provide an assembly fixture having new and improved facilities for maintaining its movable carriages in constant engagement with a reference side of a support.

SUMMARY OF THE INVENTION

With these and other objects in view, the present invention contemplates a plurality of assembly fixtures mounted on a movable turret. The fixtures each have a glass sleeve holder mounted thereon and movable upper and lower carriages which hold an upper and lower contact, respectively, and move them into a glass sleeve in overlapping relationship. The upper carriage has a magnetizable member inserted therein which is positioned such that it is in alignment with another magnetizable member which has one end thereof positioned within a coil, when the upper contact is properly inserted within the glass sleeve. Upon energization of the coil, the upper contact is magnetized to attract and support the lower contact. Passageways are formed in the fixture to introduce a forming gas into the upper end of the glass sleeve prior to the commencement of the sealing operation. Reflectors are mounted on the fixture for cooperation with stationarily mounted radiant energy sources to aid in sealing the ends of the sleeve to its respective contact. The fixture also has facilities for maintaining the movable carriages in constant engagement with a reference side of a support member. In addition, facilities are provided for more accurately holding the upper contact to maintain its proper position with respect to the glass sleeve. Furthermore, the fixture has facilities for latching the lower carriage's contact holding facilities open after the lower contact is supported by magnetization of the upper contact.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings wherein:

FIG. 1 is a perspective view of a completed sealed contact switch;

FIG. 2 is a plan view of the assembly apparatus showing a plurality of assembly fixtures mounted on an indexable turret and illustrating the various assembly stations involved in the fabrication of a sealed contact switch;

FIG. 3 is a perspective view of an assembly fixture embodying the principles of the present invention;

FIG. 4 is an exploded cross-sectional view of the upper carriage and its mounting to the assembly fixture;

FIG. 5 is a partial perspective view of the lower carriage and the facilities for latching the jaws of the lower carriage open;

FIG. 6 is an exploded partially cross-sectioned view of the assembly fixture illustrating the magnetizing facilities extending through the upper jaw, the forming gas passageways, and the pivotal member on the outer jaw for securely holding the upper contact;

FIG. 7 is a view taken along line 7—7 from FIG. 6, further illustrating the way in which the upper contact is held by the upper jaws;

FIG. 8 is a view taken along line 8—8, from FIG. 6,

illustrating the mechanism for setting a predetermined gap between the upper and lower contacts;

FIG. 9 is an exploded side elevational view of the jaws of the upper carriage holding a contact having an exaggerated defect in the shank portion thereof;

FIG. 10 is an exploded side elevational view showing the defective contact of FIG. 9 as held within a pair of rigid jaws;

FIG. 11 is a view taken along line 11—11, from FIG. 6 illustrating the positioning of a radiant energy source with respect to the lower reflector of the assembly fixture; and

FIG. 12 is an exploded, partial perspective view of the upper jaw assembly.

DETAILED DESCRIPTION

In FIG. 1, there is shown a completed sealed contact switch **20** having an upper contact **21** and a lower contact **22** sealed within a glass sleeve **23**. The upper contact **21** has a shank portion **24** and a flat paddle portion **26** which overlaps a flat paddle portion **27** of the lower contact **22** which has a shank portion **28**.

The assembly apparatus used in fabricating a sealed contact switch **20** includes a plurality of assembly fixtures **31** mounted to an indexable turret **32**, as shown in FIG. 2.

A support platform or table **33** is concentrically mounted with respect to the turret **32** and has mounted thereon various facilities which cooperate with the assembly fixtures **31** in the assembly of the sealed contact switch **20**. Each indexing step of the turret **32** brings an assembly fixture **31** into alignment with one of the facilities mounted to the table **33**. Each indexing step hereinafter is referred to as an assembly station and is numbered accordingly on FIG. 2.

OPERATION IN GENERAL

At station **1**, an upper and a lower contact **21** and **22** are inserted in proper orientation by a contact loading assembly **25** into jaws mounted to upper and lower carriages which are movable on the fixture **31**. The turret **32** then indexes the assembly fixture **31** to station **2** where a glass sleeve loading assembly **29** inserts a glass sleeve **23** into a sleeve holder mounted to the fixture **31**. After the sleeve **23** in inserted in the sleeve holder, the upper and lower carriages are moved toward each other to insert the contacts **21** and **22** into the glass sleeve **23** in spaced overlapping relationship. At this point, pressurized forming gas is introduced into a passageway in the bottom of the fixture **31** which communicates with the upper end of the open glass sleeve **23** to permit gas to flow into the glass sleeve.

The turret **32** then indexes to station **3** where a radiant heater **30** is energized to preheat the lower end of the glass sleeve **23** and the lower contact **22**. The radiant heater cooperates with a reflector mounted on the fixture **31** in a position behind the lower portion of the glass sleeve **23**. This preheating reduces the cycle time necessary in fabricating a switch. It is not necessary, however, that the preheat stations be utilized. The fixture **31** may be held in alignment with a radiant heater for a sufficient time to accomplish the seal without a separate preheating station.

Fixture **31** then indexes to station **4** where a coil mounted on the assembly fixture **31** is energized to magnetize the upper contact **21** so that it attracts and supports the lower contact **22** whereupon the lower carriage of the fixture **31** releases the lower contact **21** and is latched in an open position. Another radiant heater **35** is then energized to complete the seal of the lower contact within the lower end of the glass sleeve.

In the fabrication of a sealed contact switch, it is advantageous to first seal the bottom contact within the glass sleeve, rather than first sealing the upper contact within the upper end of the glass sleeve. In particular, when the bottom contact is sealed first, the upper contact can be securely held by the upper carriage while the lower contact is magnetically held and supported by the upper contact. If the upper seal is made first, then it is necessary for the upper carriage to release the upper contact permitting it to be held only by magnetic attraction to the lower contact. When this is done, the upper contact has a tendency to tip, resulting in improper positioning of the upper contact with respect to the glass sleeve. By sealing the lower contact first, the upper contact is held securely by the upper carriage thereby eliminating the tendency of the upper contact to tip. Likewise, the lower contact is suspended downwardly and also has no tendency to tip.

The fixture then indexes to station **5** where another radiant heater **40** preheats the upper end of the glass sleeve and the upper contact. At this point, air is introduced into another passageway in the bottom of the fixture to actuate a piston mounted to he fixture to move the glass sleeve holder, the glass sleeve **23**, and the sealed lower contact **22** laterally with respect to the upper contact **21** to accurately set a predetremined gap between the overlapping portions of the upper and lower contacts. The fixture **31** then indexes to the next station where a hood **45** is lowered over the fixture to form an enclosed chamber into which pressurized air is introduced. To decrease the cycle time of the assembly apparatus, it may be desirable to have an individual hood associated with each fixture, as disclosed in Gubitose et al. Pat. 3,273,989, so that the turret **32** may be indexed while a switch is held in a pressurized chamber. After presurization, another radiant heater **59** is energized to complete the upper seal. The flow of forming gas, which has continued during the sealing operations, is stopped immediately upon completion of the upper seal. Hood air pressure is then increased slightly to prevent bubbling of the glass sleeve caused by expansion of the gas confined within the sealed sleeve. The fixture **31** then indexes to a cooling station **7** and then to a final unloading station **8** where the completed switch **20** is withdrawn from the fixture **31** by an unloading assembly **75**.

ASSEMBLY FIXTURE

Referring now to FIG. 3, there is shown an assembly fixture **31** having a base **34** and a vertical standard **36** mounted thereto. An upper and a lower carriage **37** and **38**, respectively, are movably mounted on the standard **36**. The carriage **37** has an upper jaw assembly **39** which incudes a rigid inner jaw **41** and a pivotally mounted outer jaw **42** having a lobe **43** at the upper end thereof which cooperates with facilities, such as an air cylinder mounted to the table **33**, for opening the jaws. A spring **44** is mounted behind the lobe **43** of the outer jaw **42** to maintain the upper jaw assembly **39** in a normally closed position.

The lower carriage **38** includes a lower jaw assembly **46** having a rigid inner jaw **47** and a pivotally mounted outer jaw **48** having a lobe **49** at its lower end thereof. A spring **51** is positioned between the inner jaw **47** and the outer jaw **48** to maintain the lower jaw assembly **46** in a normally closed position. Positioned intermediate the upper and lower carriages **37** and **38**, respectively, and mounted to the standard **36** is a glass sleeve holder **52** which is movable laterally between a first and a second position by gap adjusting facilities designated **53** to be described more fully hereinafter. An upper reflector **54** is mounted to the standard **36** and is positioned such that it encompasses an upper portion of the glass sleeve **23** held within the holder **52**. The reflector **54** has a cutout portion **56**, permitting the jaw assembly **39** to be moved downwardly to its lowest position, set by adjustable stops, not shown, but which may be, for example, a screw, such as screw **50**, shown on the lower carriage **38** in FIG. 5. The cutout portion **56** permits the carriage **37** to be moved to its proper position adjacent the glass sleeve **23** without striking the carefully positioned reflector **54**. Likewise, a lower reflector **57** is mounted beneath the sleeve holder **52** and has a cutout portion **58**.

A coil **55** is mounted behind the standard **36** and has

a magnetizable core or tube 60, made of a material, such as Permalloy, mounted within the coil 55. The core 60 extends through an aperture 76 (FIG. 6) in the standard 36 which terminates at an opening 77 immediately above the upper reflector 54. The core 60 is hollow to permit forming gas to flow therethrough. The inner jaw 41 also has a hollow magnetizable tube 65, as shown in FIG. 6, inserted therein which lines up with the opening 77 (see FIG. 3) when the upper carriage 37 is moved to its lowest position. When the coil 55 is energized and the tube 65 is aligned with opening 77, the upper contact 21, held within the upper jaw assembly 39, is magnetized, causing the attraction of the overlapping portion 27 of the lower contact 22 thereto. At this time, the lower carriage 38 releases the shank portion 28 of the lower contact 22 so that the lower contact is solely supported by the upper contact 21. It is to be noted that the magnetic field is transmitted to the upper contact 21 only when the tube 65 in the inner jaw 41, is in alignment with the opening 77 and when the coil 55 is energized.

Referring now to FIG. 4, there is shown the upper carriage 37 mounted on the standard 36 which has a beveled surface 61 on the rear side thereof. A roller 62 having a complimentary beveled periphery, is fixed to a shaft 67 which is rotatably mounted to the carriage 37. A spring 63 urges a member 68 against an enlarged end of the shaft 67 which in turn urges the roller 62 against the beveled surface 61. The roller 62 is urged against the beveled surface 61 to provide sufficient frictional force between the carriage and the standard 36 to prevent relative movement therebetween except by the application of external forces to the carriage. In addition, the resultant force of the beveled roller 62 acting against the beveled surface 61 causes a side plate 64 of the carriage 37 to wear against a side surface 66 of the standard 36 and causes the surface 69 of the inner jaw 41 to wear against the adjacent surface 70 of the standard 36. This permits the carriage 37 and its corresponding jaw assembly 39 to be accurately positioned with reference to the surfaces 66 and 70 of the standard 36 at all times regardless of wear or dimensional changes due to thermal expansion of any part of the apparatus.

As shown in FIGS. 3 and 5, the base 34 of the assembly fixture has three holes therethrough 71, 72, and 73 which are in alignment with corresponding holes (not shown) in the turret 32. Tubing (also not shown) connects these holes in the turret 32 to a plurality of valves and gas manifolds which regulate the flow of gas through the holes 71, 72, and 73 at prescribed times during the assembly cycle of the apparatus. A tube 74 connects the hole 71 in the base 34 with the hollow core 60. As shown in FIG. 6, the inner jaw 41 has a hollow tube 65 therethrough, which when aligned with the core 60 permits forming gas to flow through tube 74 into the upper end of the glass sleeve 23.

The outer jaw 42 of the upper jaw assembly 39 has a channel 81 formed therein which fits over a projecting portion 82 on the inner jaw 41, as show in FIGS. 6 and 7. A contact 21 is held by its shank 24 between the flat surface of the projecting portion 82 and a member 83 which is pivotally mounted on a pin 84 in the channel 81 of the outer jaw 42. The member 83 is shorter than the depth of the channel 81 so that the sides 86 of the jaw 42 fit over the projection 82 on the lower jaw 41, as shown in FIG. 7. This provides a relatively enclosed passageway 87 surrounding the shank portion 24 of the contact 21. Thus, gas flowing through the hollow core 60 and tube 65 is directed into the channel 81 of the outer jaw 42 and then downward through the passageway 87 into the glass sleeve 23.

The pivotal member 83 is provided to compensate for any irregularities or defects in the shape of the shank of a contact. Referring now to FIG. 9, there is shown a contact 21 having a shank portion 24 which has a greatly exaggerated irregularity 89 formed therein which may result, for example, from burrs on the material or variations in the diameter of the shank. The outer jaw 42 engages the shank 24 between the projecting portion 82 and the two extensions 78 of the pivotal member 83. The member 83 pivots to follow the contour of the shank 24 as closely as possible thereby providing maximum contact between the two jaws 41 and 42 to hold the contact 21 securely. If only a rigid outer jaw were provided, such as jaw 85, shown in FIG. 10, a contact 21 having an irregularity 89 would be gripped with only point contact on one jaw thereby permitting movement of the contact within the jaws. It is clear that in assembly apparatus of this type, the upper contact 21 must be held very accurately and securely in the position in which it is loaded, since the position of the upper contact is the reference position for the lower contact; that is, the ultimate position of the lower contact is determined by the position of the upper contact.

Referring now to FIG. 5, there is shown the lower carriage 38 with the lower jaw assembly 46. A beveled roller 90 is mounted to the carriage 38 and cooperates with the beveled surface 61 of the standard 36, the same as was previously described for roller 62. The lower jaw assembly 46 is substantially the same as the upper jaw assembly 39 except that it has no magnetizing facilities or forming gas flow facilities. A latching arm or latch 91 having a projection 92 at one end and a cam surface 93 formed at the other end is pivotally mounted by pin 94 to the lower carriage 38. A cam 96 is stationarily mounted to the base 34 of the assembly fixture 31. When the carriage 38 is moved downwardly, the cam 96 engages the surface 93 and pivots the arm 91 clockwise thereby moving the projection 92 out from between the outer jaw 48 and inner jaw 47, thus permitting the jaws to close. When the carriage 38 is moved upwards the jaws remain in their closed position until an air cylinder (not shown) is actuated to engage the lobe 49 to open the jaws whereupon a spring 97 urges the latch 91 counterclockwise so that the projection 92 is inserted between the inner jaw 47 and the outer jaw 48 to maintain the jaws open until the carriage 38 is again moved downwardly. The use of latch 91 permits the lower jaw assembly 46 to open immediately after the magnetization of the upper and lower contacts, and remain open for the remainder of the assembly cycle without the necessity of having extraneous facilities, such as a cam surrounding the periphery of the turret 32, continue to engage the lobe 49.

Referring now to FIG. 8, there is shown a view illustrating in detail the gap adjusting facilities 53 and the sleeve holder 52. The glass sleeve 23 is inserted into a groove 98 formed in the sleeve holder 52. A roller 99 is urged by a spring 101 into the groove 98 and serves to resiliently hold the glass sleeve 23 when loaded therein. Any resilient mounted member could be used to hold the glass sleeve. The glass sleeve holder 52 is mounted to a block 102 which is movable laterally. A dual piston air cylinder 104 is mounted behind the glass sleeve holder 52, as shown in FIGS. 3 and 6. The cylinder 104 has two bores 105 and 106 therein which pistons 107 and 110 are slidably mounted. The ends of the pistons 107 and 110 are adjacent to a pair of levers 113 and 114, each of which have their other ends in engagement with the sliding block 102. Levers 113 and 114 are pivotally mounted at 116 and 117, respectively, to a stationary member 115. When pressurized air is introduced into an aperture 108 which communicates with bore 105, the piston 107 moves outwardly pivoting lever 113, which urges the block 102 and sleeve holder 52 to the left, as viewed in FIG. 3. Aperture 108 is connected to a tube 112 which communicates with passageway 73 in the base 34 of the assembly fixture, as shown in FIG. 5. Aperture 109 is connected to a tube 111 which communicates with the passageway 72 in the base 34. The introduction of air into either tube 111 or 112 causes either piston 107 or piston 110 to pivot a lever 113 or 114 to move the block 102, which correspondingly moves the glass sleeve holder 52. The movement of the block 102 is limited by an adjusting screw 122

which is inserted in a threaded aperture **123** in block **115**. The screw has a tapered end **124** which fits within a tapered bore **126** in the sliding block **102**. By adjusting the amount that the tapered end **124** extends into the bore **126**, it is possible to accurately limit the distance which the sliding block **102** and glass sleeve holder **52** move. This sliding or shifting movement of the holder **52** is used to properly and accurately set the gap between the overlapping paddle portions **26** and **27** of the upper and lower contacts **21** and **22** after the bottom contact **22** is sealed within the glass sleeve. The sequence of operation of the gap adjusting facilities **53** is described more fully in the description of the complete operation of the apparatus.

In FIG. 11, there is shown one of the radiant energy sources **35** which includes a lamp **118**, such as an infrared energy, quartz-iodine lamp, mounted at one of the foci of a semi-elliptical reflector **119**. The reflector **119** focuses the radiant energy onto a lower portion of the glass sleeve **23**, in a manner such as disclosed, for example, in R. M. Pinkham et al. Pat. 3,282,669. The lower reflector **57** partially encompasses the lower portion of the sleeve **23** so as to direct radiant energy onto the portion of the glass sleeve **23** which does not directly receive radiant energy generated and focused by the lamp **118** and reflector **119**. The reflector **57**, and likewise reflector **54**, are adjustable in order to provide a uniform distribution of radiant energy about the periphery of the glass sleeve. In FIG. 3, a screw **121** is shown which can be loosened to permit reflector **54** to be moved until the desired uniform distribution of energy is provided. The reflector **57** has a similar adjusting screw, which is not shown. It is to be noted that all of the radiant energy sources including **30**, **35**, **40**, and **59**, are similar in structure to source **35** described above. However, radiant energy sources **40** and **59** are positioned vertically higher than sources **30** and **35** in order to be in alignment with the upper reflector **54** and an upper portion of the glass sleeve **23**.

OPERATION

At the beginning of a cycle of operation, the assembly fixture **31** has its upper and lower carriages **37** and **38**, positioned respectively against an upper stop **79** and a lower stop **80**, as shown in FIG. 3. At this point, both jaw assemblies **39** and **46** are closed. The turret **32** indexes eight times to make a complete revolution. Each indexing step is referred to as a station and is numbered accordingly on FIG. 2.

At station **1**, a pair of air cylinders (not shown) mounted to the support table **33** are actuated to engage the lobes **43** and **49** of the upper outer jaw **42** and the lower outer jaw **48**, respectively, to open the jaws. The air cylinders are positioned angularly with respect to the standard **36** so that a component of force on the upper jaw acts to hold the upper carriage **37** against stop **79**, as well as causing the outer jaw **42** to pivot and open. Similarly, the lower air cylinder is positioned to hold the lower carriage against stop **80** as well as to open the jaw **48**. While the jaws are open, an upper contact **21** and a lower contact **22** are inserted in proper orientation by the contact loading assembly **25** which is mounted to the table **33** in alignment with station **1**. In response to the introduction of the contacts between the jaws, the air cylinders are deactuated thereby permitting the outer jaws **42** and **48** to engage the shanks **21** and **28** of the upper and lower contacts **21** and **22**, respectively, to grip the contacts and hold them securely. After the contacts are gripped by the jaws, the contact loading assembly **25** is retracted and the turret **32** indexes the assembly fixture **31** to station **2**.

At station **2**, a glass sleeve **23** is loaded by the sleeve loading assembly **29** into the groove **98** of the sleeve holder **52** and is held therein by the resiliently mounted roller **99**. At this point, the glass sleeve holder **52** is positioned as far leftward as possible, viewing the fixture **31** as shown in FIG. 3. Air cylinders, stationarily mounted to the table **33** at station **2**, are then actuated to move the upper and lower carriages **37** and **38** toward each other. It is to be noted that the contacts **21** and **22** are loaded into the jaw assemblies in misalignment with one another so that they move into the glass sleeve in overlapping relationship. Furthermore, at station **2**, forming gas is permitted to flow through tube **74**, core **60**, and tube **65**, into the upper end of the glass sleeve **23**. The turret **32** then indexes to station **3**.

At station **3**, the radiant energy source **30** is energized to direct focused radiant energy against the lower end of the glass sleeve **23** to preheat the glass sleeve and the lower contact **22**. The radiant source **30** cooperates with the stationarily mounted lower reflector **57** which is adjustable toward and away from the source **30** to achieve a uniform distribution of energy around the peripheral portion of the glass sleeve which is to be heated. This preheating step helps to reduce the cycle time in assembling a switch; however, it is not necessary that such a step be included. Accordingly, if desirable, station **3** may be eliminated. The turret **32** then indexes to station **4**.

At station **4**, an air cylinder is actuated to force the carriage **38** upward in order to insure that the carriage has not lowered during the indexing of the fixture from one station to another, such as may be caused by vibration of the apparatus. This makes certain that the lower contact **22** is properly positioned within the glass sleeve **23**, prior to sealing, and that its paddle portion **27** properly overlaps the paddle portion **26** of the upper contact **21**. At this station, the electrical contacts **127** for the coil **55**, engage stationary contact (not show) to energize the coil **55** to magnetize the upper contact **21** through the core **60** and tube **65**, as previously described. The magnetized upper contact **21** attracts the overlapping portion of the lower contact **22** to support and hold the lower contact. Another air cylinder is then actuated to move the outer jaw **48** away from the inner jaw **47**, thereby permitting the spring loaded latch **91** to move between the inner jaw **47** and outer jaw **48** to latch the jaws in an opened position. The lower contact **22** is then supported only by the magnetic forces of the upper contact **21**. Then radiant source **35** is energized and the radiant energy is focused by the reflectors **119** and **57** to uniformly distribute the energy about the lower peripheral portion of the glass sleeve **23** to heat and melt the glass to seal the lower contact **22** within the glass sleeve **23**. The lower jaw assembly **46** remains in its uppermost position adjacent to the lower reflector **57** during the sealing of the lower contact **22** within the glass sleeve **23**. The open jaws **47** and **48** permit the round shank **28** of the lower contact **22** to rotate about its axis or to move parallel to the faces of the jaws **47** and **48** so that the overlapping paddle portions of contacts **21** and **22** are in complete contact with each other; however, the jaws limit movement of the contact **22** perpendicular to the faces of jaws **47** and **48**. It is to be noted that the forming gas has been flowing through the glass sleeve since station **2** and continues to flow. Turret **32** then indexes fixture **31** to station **5**. The upper contact **21** remains magnetized at this time.

At station **5**, radiant source **40** is energized to preheat the upper end of the glass sleeve **23** in cooperation with the upper reflector **54**. After preheating, the turret **32** is then indexed to station **6**. At a position between station **5** and station **6**, facilities (not shown), such as a cam, open a valve to introduce air into passageway **109** to force the piston **110** outwardly, pivoting lever **114** to force the sliding block **102** and the glass sleeve holder **52** to the right as viewed in FIG. 3. This moves the glass sleeve **23** and the sealed lower contact **22** a predetermined distance away from the upper contact **21**, which is still held in the upper jaw assembly **39**, to set the gap between the overlapping paddle portions **26** and **27** of the contacts. Simultaneously therewith, the coil **55** is deenergized to release the overlapping portions of contacts **21** and **22**.

At station 6, a hood 45 is lowered over the fixture 31 to provide an enclosed chamber which is pressurized with air. The purpose of the pressurized chamber is to achieve a gas pressure inside the completed switch which is sufficient to eliminate arcing at the required operational voltage level. Then radiant energy source 59 is energized and radiant energy is focused and directed through a window 128 in the hood 45 to make the upper seal. Forming gas continues to flow through tube 74, core 60, and tube 65 into the glass sleeve 23 until the upper seal is made, whereupon the flow of forming gas is immediately stopped to prevent dimpling or deformation of the seal. Simultaneously, when the upper seal is made, the air pressure within the hood is increased slightly to compensate for the increase in the pressure of the forming gas sealed inside the glass sleeve to prevent bubbling of the glass sleeve 23. The radiant source 59 is also deenergized upon making the seal. After a predetermined time, the hood pressure is released, the hood raised, and the fixture 31 indexed to station 7, where the assembled switch 20 is permitted to cool. The turret 32 then indexes the fixture 31 to station 8.

At station 8, stationarily mounted air cylinders, not shown, are actuated to move the carriages 37 and 38 away from each other toward their respective stops 79 and 80. As the carriages are moved, the jaws 42 and 48 are pivoted to open so that they move freely past the shank portions 24 and 28 of the upper and lower contacts. While the outer bottom jaw 48 is already held open by the latch 91, it is nevertheless opened further to permit the projection 92 of the latch 91 to move out from between jaws 47 and 48 without restriction when cam 96 engages the cam surface 93 and pivots the latch 91 during downward movement of the carriage 38. Then the unloading assembly 75 is actuated to engage the glass sleeve and gently remove it from the sleeve holder 52 and deposit it in a bin. The fixture then indexes to station 1. At a position between station 8 and station 1, a valve is actuated to direct air into passageway 108 to move the glass sleeve holder 52 back to its initial leftward position to receive the next glass sleeve 23. This completes one cycle of operation.

It is to be understood that the above-described apparatus is simply illustrative of an application of the principles of the invention. Numerous other modifications to the apparatus and its operating cycle may be made by persons having ordinary skill in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In an apparatus for assembling a sealed contact switch having an upper and a lower contact sealed within a glass sleeve, said apparatus including a glass sleeve holder and upper and lower carriages for holding upper and lower contacts, respectively, said carriages being movable from positions spaced from said glass sleeve holder to positions adjacent to said glass sleeve holder wherein said contacts are positioned within said glass sleeve in overlapping relationship, the improvement which comprises:

a vertical standard;

means for mounting said carriages on said vertical standard for vertical sliding movement;

a coil mounted adjacent to said standard;

a first magnetizable member having a first end mounted into said coil and a second end extending through said standard;

said upper carriage having an inner jaw and an outer jaw for holding said upper contact therebetween, said inner jaw having a second magnetizable member mounted therein and positioned such as to have one end adjacent to said upper contact and the other end adjacent to and in alignment with said second end of said first magnetizable member when said upper carriage is in the position adjacent to said glass sleeve holder; and

means for energizing said coil to magnetize said first member and said second member to magnetize said upper contact to attract the overlapping portion of said lower contact so that said lower contact is supported by said contact.

2. Apparatus for assembling a sealed contact switch as set forth in claim 1, wherein:

said first and second magnetizable members are tubular to permit forming gas to flow into the upper end of said glass sleeve.

3. Apparatus for assembling sealed contact switches having an upper and a lower contact sealed within a glass sleeve comprising:

a base;

a vertical standard mounted on said base;

means mounted to said standard for holding a glass sleeve;

upper and lower carriage means movable on said standard for holding an upper and a lower contact, respectively, and for moving said contacts into said glass sleeve in overlapping relationship;

means rendered effective by said upper contact being moved into said glass sleeve for introducing gas into the upper end of said glass sleeve and for magnetizing said upper contact;

means for directing energy from an infrared source at a lower portion of said glass sleeve;

a lower reflector mounted to said standard, said lower reflector shaped and positioned to reflect said directed infrared energy so as to provide a uniform distribution of infrared energy about the periphery of said lower portion to seal said lower portion of said glass sleeve to said lower contact;

means for moving said glass sleeve and sealed lower contact relative to said upper contact to set a predetermined gap between the overlapping portions of said upper and lower contacts;

means for directing energy from an infrared source at an upper portion of said glass sleeve; and

an upper reflector mounted to said standard, said upper reflector shaped and positioned to reflect said directed infrared energy so as to provide a uniform distribution of infrared energy about the periphery of said upper portion to seal said upper portion of said glass sleeve to said upper contact.

4. Apparatus for assembling sealed contact switches having an upper and a lower contact sealed within a glass sleeve comprising:

a base;

a vertical standard mounted on said base;

means mounted to said standard for holding the glass sleeve;

upper and lower carriage means movable on said standard for holding an upper and a lower contact, respectively, and for moving said contacts in overlapping relationship into said glass sleeve;

means rendered effective by the movement of said upper contact into said sleeve for directing a stream of forming gas into the upper end of said glass sleeve;

means rendered effective by the movement of said upper contact into said sleeve for magnetizing the upper contact;

means for latching said lower carriage open after magnetization of said upper contact to release said lower contact;

means for directing and focusing energy from an infrared source at an upper portion of said glass sleeve;

means for directing and focusing energy from an infrared source at a lower portion of said glass sleeve;

an upper reflector mounted to said standard, said upper reflector shaped and positioned to partially encompass said upper portion of said glass sleeve to reflect infrared energy from said upper infrared energy directing means to heat the encompassed portion of said glass sleeve, said upper reflector being adjustable

toward and away from said glass sleeve in order to provide a uniform distribution of infrared energy about the periphery of said upper portion;

a lower reflector mounted to said standard, said lower reflector shaped and positioned to partially encompass said lower portion of said glass sleeve to reflect infrared energy from said lower infrared energy directing means to heat the encompassed portion of said glass sleeve, said lower reflector being adjustable toward and away from said glass sleeve in order to provide a uniform distribution of infrared energy about the periphery of said lower portion;

means for actuating said lower infrared energy directing means to heat and seal said lower portion of said glass sleeve to said lower contact;

means mounted to said standard for moving said glass sleeve and sealed lower contact laterally with respect to said upper contact to set a predetermined gap

between the overlapping portions of the upper and lower contacts; and

means for actuating said upper infrared energy directing means to heat and seal said upper portion of said glass sleeve to said upper contact.

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ARTHUR D. KELLOGG, Primary Examiner

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