Feb. 5, 1957 A. F. PITYO 2,779,993

METHOD OF PRODUCING A DIODE ELEMENT

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FIG. 1.

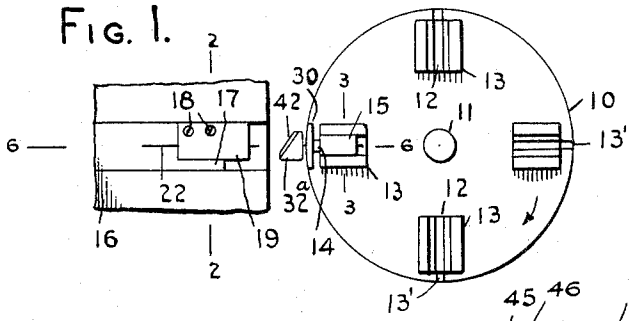

FIG. 2.

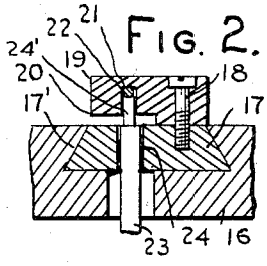

FIG. 3.

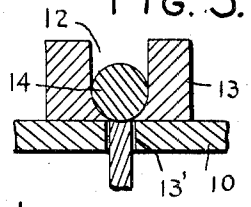

FIG. 6.

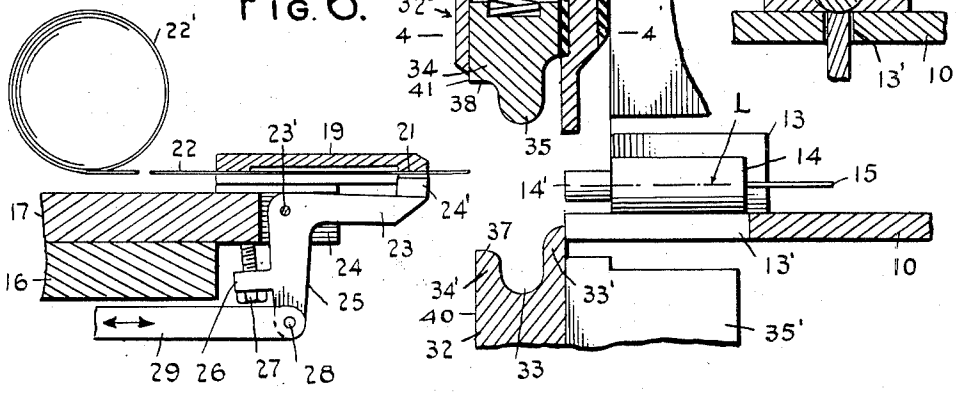

FIG. 7.

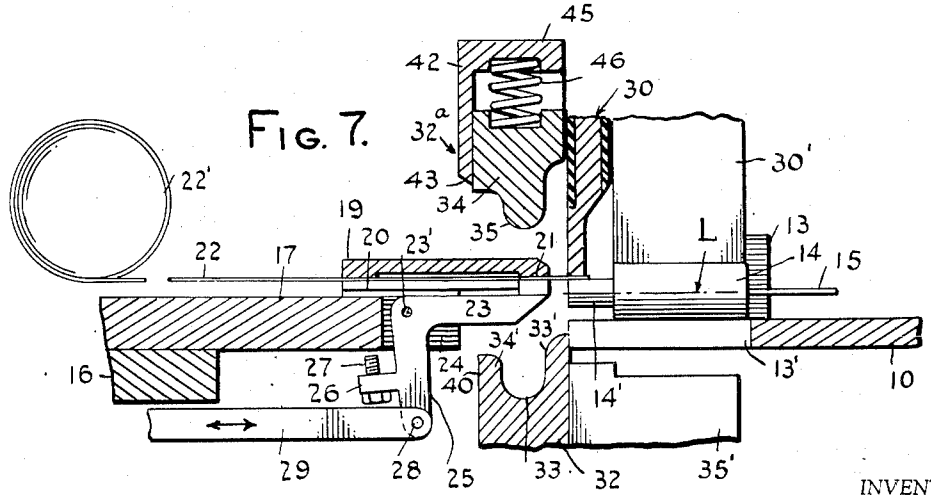

FIG. 4.

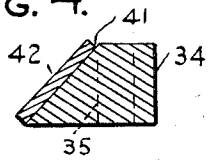

FIG. 5.

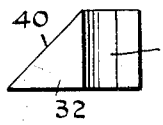

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FIG. 8.

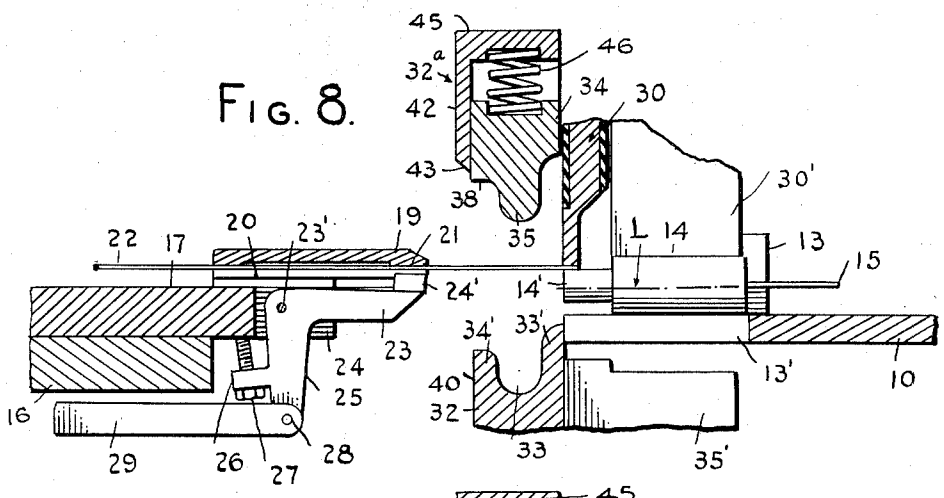


FIG. 9.

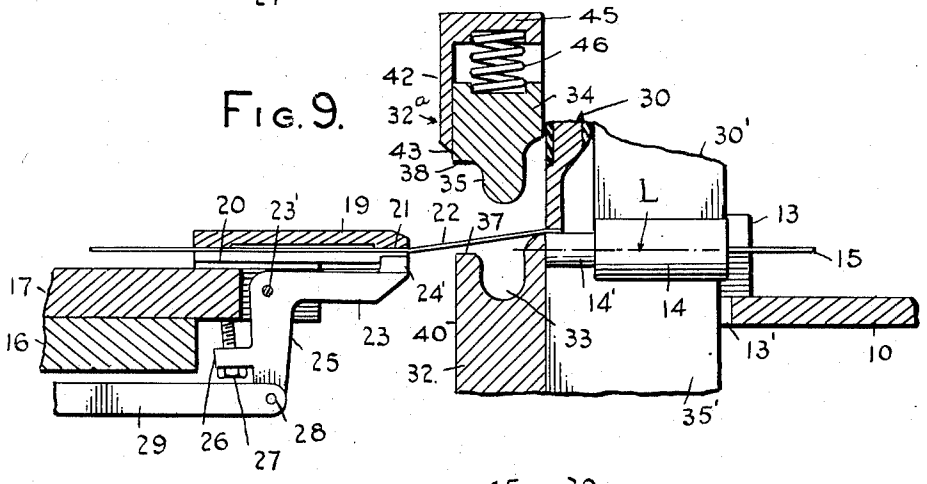


FIG. 10.

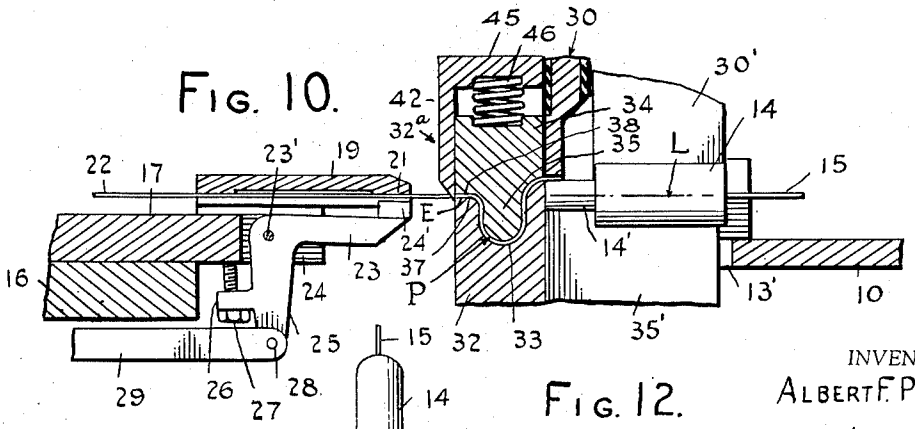


FIG. 11.

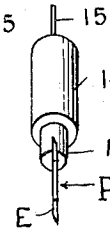
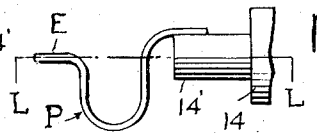


FIG. 12.



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United States Patent Office

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METHOD OF PRODUCING A DIODE ELEMENT

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Application August 17, 1953, Serial No. 374,502

13 Claims. (Cl. 29—155.5)

This invention relates to a method of producing a diode element or the like.

An important object of the invention is to provide a method including the steps of feeding a wire to an anode, welding the wire to the anode, forming the wire to produce the whisker, and then severing the wire to complete the product, all steps being carried out in proper sequence.

A further object of the invention is to provide a method which will produce a sharp end or point upon the formed whisker, and which will hold such end accurately in alignment with the center of the anode within a tolerance of about .005 of an inch.

A further object of the invention is to provide a method of the above mentioned character for performing the steps accurately and quickly.

Other objects and advantages of the invention will be apparent during the course of the following description:

In the accompanying drawings forming a part of this application and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a plan view, partly diagrammatic of apparatus used in the practice of my method,

Figure 2 is a transverse section taken on line 2—2 of Figure 1,

Figure 3 is a transverse section taken on line 3—3 of Figure 1,

Figure 4 is a horizontal section taken on line 4—4 of Figure 6,

Figure 5 is a plan view of the lower forming jaw,

Figure 6 is a vertical section taken on line 6—6 of Figure 1, parts broken away, showing the position of the various apparatus elements, prior to the first step in the method,

Figure 7 is a similar view, showing the position of the elements for performing the first step in the method,

Figure 8 is a similar view, showing the position of the elements in performing the third step of the method,

Figure 9 is a similar view, showing the position of the elements when performing the fourth step in the method,

Figure 10 is a similar view, showing the position of the elements when performing the fifth or final step of the method.

Figure 11 is a perspective view of the finished product, and,

Figure 12 is a side elevation of the finished product.

The machine to be used in the practice of the method comprises a horizontal turret 10, which is indexed by a vertical shaft 11, turned by any suitable means. The turret 10 may be turned clockwise, as shown in Figure 1. The turret 10 is provided upon its upper face with a plurality of spaced radial anode holding pockets or recesses 12, formed in blocks 13 rigidly secured to the turret. The turret is provided with radial slots 13', which lead into the recesses 12, Figure 3. The pockets or recesses 12 are adapted to receive and hold cylindrical pins or anodes 14, having reduced extensions 14'. The anodes 14 and the extensions 14' are cylindrical and are preferably formed of nickel. Welded to one end of each

anode is a lead wire 15, arranged at the center of the anode. The wire 15 is welded to the anode prior to the introduction of the anode into the pocket 12, and the welding of the wire to the anode forms no part of the present invention. The turret 10 is indexed to bring each anode held within the pocket 12 to a selected position P, at which the several steps of the method are practiced.

The numeral 16 designates a stationary guide arranged near the turret 10. This stationary guide has a recess 17' formed therein, Figure 2, which is undercut to receive a slide 17. The slide moves in a fixed horizontal path which is radial with respect to the turret 10. Arranged above the slide 17 and rigidly secured thereto by screws 18 or the like, is a stationary jaw 19, having a lower face 20, spaced slightly from the slide 17. This lower face has a longitudinal groove 21 formed therein which receives a wire 22, fed from a spool 22'. The wire 22 is preferably formed of tungsten, silver, gold, platinum or the like.

Arranged beneath the stationary jaw 19 is a movable jaw 23 operating within a slot 24 formed in the slide 17, and pivotally mounted upon the slide by a pin 23', to swing in a vertical plane. The jaw 23 has an extension 24 at its free end, movable into the longitudinal groove 21, for clamping engagement with the wire 22. Rigidly connected with the jaw 23 is a depending arm 25, provided with a horizontal extension 26, carrying a stop screw 27 to contact with the slide 17, for controlling the extent of opening movement of the jaw 23. The arm 25 is pivotally connected at 28 with a link 29, which is movable horizontally in opposite directions and which is shifted by any suitable means.

It might be stated at this point that the wire 22 remains permanently within the groove 21, during the operation of the apparatus in the practice of the method, and when the link 29 is moved forwardly the wire is clamped within the groove 21 and moved forwardly. The wire 22 originally extends beyond the jaws 19 and 23 for a short distance, such as about one sixteenth of an inch, although this may vary. The forward end of the wire will then be brought into overlapping relation with the reduced portion 14' of the anode.

The numeral 30 designates a welding electrode, which is moved vertically by any suitable means and which is spring pressed downwardly. Rigidly connected with the electrode 30 to move therewith is a vertical presser plate or web 30', which is radial with respect to the turret 10 to enter the top of the pocket or recess 12. The electrode 30 is connected with one side of a welding circuit and is thoroughly insulated from the turret and all other parts of the machine, the opposite side of which circuit is elelectrically connected with the turret 10, each block 13 and the anode held therein.

The apparatus comprises means for forming a U-shaped portion in the wire, between the anode 14 and the jaws 19 and 23. The forming means is arranged between the turret 10 and jaws 19 and 23 and comprises a vertically movable jaw 32, having a recess 33 forming upstanding portions 33' and 34'. The forming means further comprises a vertically movable jaw 34, arranged near the electrode 30 and movable independently of the electrode. The jaw 34 has a depending extension 35 to enter the recess 33 of the jaw 32. The jaw 32 has a vertical presser plate or web 35' rigidly secured thereto, which is radial with respect to the turret 10 to enter the slot 13'. The extension 34' has a horizontal shoulder 37 and the jaw 34 has a horizontal shoulder 38.

The lower forming jaw 32 has a vertical face 40, Figure 5, which is horizontally inclined and the upper jaw 34, Figure 4, has a vertical face 41 which is horizontally inclined. The faces 40 and 41 are in alignment.

Slidably mounted upon the upper jaw 34 is a blade or cutter 32 and this blade or cutter is horizontally inclined and will slidably contact with the faces 41 and 40. The blade 42 has a lower cutting edge 43. The blade 42 has a horizontal extension 45, engaging a coil spring 46, engaging the top of the upper jaw 34. In operation, the jaw 34 and blade 42 may move downwardly as a unit, and after the forming action is completed, the blade 42 then moves downwardly with respect to the jaw 34 to sever the wire, the spring 46 being compressed.

Figure 6 shows the relative positions of the different elements of the apparatus, prior to the starting of the method. The jaw 34 is raised, electrode 30 is raised, jaw 32 is lowered and jaws 19 and 23 are in the rear position and jaw 23 is in the open position. The wire 22 is permanently retained within the groove 21, and when the turret 10 is indexed, the anode 14 is brought in alignment with the wire 22, and the upper face of the reduced extension 14' will be at the elevation of or in the line of feed of the wire. The turret 10 is now stationary, and the link 29 is moved forwardly, swinging jaw 23 upon its pivot 23', clamping the wire between the jaws 19 and 23. The wire now extends beyond the jaws 19 and 23 for a suitable distance which may be about a sixteenth of an inch although this length may vary. With the wire clamped to the jaws, the further forward movement of the link 29 moves the slide 17 forwardly and the jaws 19 and 23 move forwardly and position the free end of the wire over the reduced extension 14'. This step is shown in Figures 6 and 7. The electrode 30 which is spring pressed downwardly now moves downwardly and the electrode firmly presses the wire 22 against the extension 14', while the presser plate 30' bears against the anode 14, holding it against movement. The slide 17 remains stationary at the forward position, until the welding is completed. The welding circuit is now closed for the proper welding time, and opened by the timing means at the end of the welding time, and the wire 22 is securely welded to the reduced extension 14'. The electrode 30 remains in the lowered position and continues to bear against the wire 22, and the link 29 is now moved rearwardly from the turret. As soon as the link 29 moves rearwardly, the jaw 23 is shifted to the opened position and the jaws 19 and 23 then slidably engage the wire, and further rearward movement of the slide 17 is affected by the continued rearward movement of the link 29. When the slide 17 reaches the end of its rearward movement, it is held stationary, at this position, until the starting of the next cycle of operation. The jaw 23 now remains in the opened position. This step is illustrated in Figure 8 of the drawings.

The lower forming jaw 32 is now moved upwardly and the upstanding portion 33' first contacts with the wire and the presser plate 35' contacts with the anode and the further upward movement of the lower forming jaw is continued so that the anode 14 is raised until its center line L is in alignment with the line of feed of the wire. The electrode and upper presser plate 30 which are downwardly spring pressed are forced upwardly but these parts remain in engagement with the work. This step is shown in Figure 9 of the drawings.

The lower forming jaw 32 remains in the raised position, Figure 9 and Figure 10 and the upper forming jaw 34 is now moved downwardly to the lowermost position, Figure 10. The extension 35 enters the recess 33 and the U-shaped portion P is formed in the wire. The shoulders 37 and 38, Figure 10 form a horizontal extension E in the wire, and this extension is in alignment with the center line L of the anode, and is held in such alignment within a tolerance of .005 of an inch. The groove 21 is sufficiently wide to slidably receive the wire, and accurately holds it against horizontal displacement and in a true line of feed. When the upper forming jaw 34 is moved downwardly to form the U-shaped portion, the wire is payed out from the spool 22', since it now slidably engages the jaws 19 and 23. The upper forming jaw is firmly pressed toward the lower forming jaw, and after the U-shaped portion P has been formed, the blade 42 is moved downwardly with respect to the jaw 34, and the wire is severed, at an incline of 45°, forming a sharp point on the extension E.

The slide having been returned to the rear position, the upper forming jaw 34 is returned to the raised position, the blade 42 to the raised position with respect to the jaw 34 and the forming jaw 32 to the lowered position, and the finished product will be lowered and held in the pocket 12, and may now be removed from this pocket, since the various parts of the apparatus again assume the position shown in Figure 6. This completes the cycle of operation.

It is to be understood that the form of my invention herewith shown and described are to be taken as preferred embodiment of the same, and that changes may be made in the steps of the method, and in the order of such steps, without departing from the spirit of the invention or the scope of the sub-joined claims.

Having thus described my invention, what I claim is:

1. The method of forming a diode element, comprising holding an anode element in a selected position, moving the wire longitudinally in a fixed line of feed toward the anode element and bringing the wire into contact with the anode element and pressing the wire against the anode element and welding the wire to the anode element to form a welded joint, forming a laterally extending portion in said wire and paying out the wire from its end remote from the welded joint, then severing the wire at a point remote from welded joint and holding the severed end of the laterally extending portion in substantial alignment with the center of the anode element.

2. The method of forming a diode element, comprising feeding a wire in one direction in a fixed line, supporting an anode in a position so that the wire has its end brought into overlapping relation with a part of the anode while the center of the anode is out of alignment with the line of feed of the wire, pressing the wire against the anode and welding the wire to the anode, paying out the wire toward the point of welding and forming a laterally extending portion in the wire and an extension on said laterally extending portion, holding said extension in the line of feed of the wire, shifting the anode so that its center is in substantial alignment with the line of feed of the wire, and then severing the extension upon an inclination.

3. The method of forming a diode element, comprising holding an elongated anode element having a central longitudinal axis substantially horizontal in a selected position, moving a wire longitudinally in a substantially horizontal line of feed which extends longitudinally of said central longitudinal axis and into exterior overlapping relation with a portion of said anode element which is laterally spaced from said central longitudinal axis, then stopping the feeding of the wire and releasing the wire so that its rear portion is free to pay out forwardly toward the anode element, welding the wire to said portion of the anode element, moving upper and lower forming jaws into engagement with said wire at a position rearwardly of the welding point and thereby forming a generally U-shaped portion in said wire and an extension upon one side of said U-shaped portion while paying out the wire in said forward direction, said forming serving to hold said extension against movement, shifting the anode element vertically to bring its central longitudinal axis in alignment with said extension, severing the extension while held by the forming jaws, and separating the generally U-shaped portion from the forming jaws.

4. The method of forming a diode element, comprising holding an elongated anode element having a central longitudinal axis in a selected position, moving a wire in a longitudinal line of feed which extends longitudinally of said central longitudinal axis and forwardly toward

the anode element to bring the forward end of the wire in exterior overlapping relation with a portion of said anode element which is spaced laterally from said central longitudinal axis, then stopping the feeding of the wire and releasing the wire so that its rear portion is free to pay out forwardly toward the anode element, then welding the wire to the anode element, then moving forming jaws into engagement with said wire at a position rearwardly of the welding point and simultaneously shifting the anode element to bring said central longitudinal axis into alignment with said line of feed, said forming jaws forming a generally U-shaped portion in said wire and an extension upon one side of said generally U-shaped portion, said forming jaws holding said extension in alignment with said central longitudinal axis, severing said extension while being held, and then releasing the formed wire.

5. The method of forming a diode element, comprising holding an elongated anode element having a central longitudinal axis in a selected position, moving a wire longitudinally in a line of feed which extends longitudinally of said central longitudinal axis and thereby bringing the forward end of the wire into exterior overlapping relation with a portion of the anode element which is spaced laterally from said central longitudinal axis, then stopping the feeding of the wire and releasing the wire so that its rear portion is free to pay out forwardly toward said anode element, welding the wire to the anode element, then forming a laterally extending loop in said wire and an extension upon one side of said loop while paying out the wire in a forwardly direction, said forming serving to locate the extension in said line of feed, shifting the anode element laterally to bring its central longitudinal axis in alignment with said line of feed, and then severing said extension.

6. The method of forming a diode element, comprising holding an elongated anode element having a central longitudinal axis in a selected position, moving a wire longitudinally in a line of feed which extends longitudinally of said central longitudinal axis and bringing the wire in exterior overlapping relation with the anode at a point spaced laterally from said central longitudinal axis, welding the wire to the anode element, then paying out the wire toward the point of welding and forming a laterally extending loop in said wire and an extension upon one side of said loop, arranging the extension in alignment with said central longitudinal axis, and then severing said extension.

7. The method of forming a diode element, comprising holding an elongated anode element having a central longitudinal axis in a selected position, moving a wire longitudinally in a line of feed which extends longitudinally of said central longitudinal axis and into exterior overlapping relation with a portion of said anode element which is laterally spaced from said central longitudinal axis, stopping the feeding of the wire and releasing the wire so that its rear portion may pay out in a forward direction, the side of the wire remote from the anode element being uncovered, welding the wire to said portion of the anode element, then shifting the anode element laterally with respect to the line of feed, forming a single laterally extending loop only in said wire rearwardly of the point of welding and an extension upon the side of said loop remote from the anode element while paying out the wire in a forward direction, said forming also holding the extension and locating said extension in alignment with said central longitudinal axis, severing the extension while being held, and then releasing the formed wire.

8. The method of forming a diode element, comprising holding an elongated anode element having a central longitudinal axis in a selected position, moving a wire longitudinally in a line of feed which extends longitudinally of said central longitudinal axis and into overlapping relation with a portion of said anode element which is laterally spaced from said central longitudinal axis, the wire being arranged exteriorly of said portion, arranging forming jaws upon opposite sides of and spaced from the wire when the forming jaws are in the open position so that the wire is fed between the forming jaws, stopping the feeding of the wire and releasing the wire so that its rear portion is free to pay out in a forward direction, welding the wire to said portion of the anode element, then effecting a relative lateral movement between the anode element and the line of feeding to bring said central longitudinal axis in alignment with said line of feeding, then moving the forming jaws inwardly into engagement with said wire and thereby forming a laterally extending loop and an extension upon one side of said loop while paying out the wire in a forwardly direction, said forming also locating said extension in alignment with the line of feed and said central longitudinal axis, severing the extension while being held by the forming jaws, and then separating the formed wire from said forming jaws.

9. The method of forming a diode element, comprising holding an anode element at a selected position, feeding a wire toward the anode element to a point which is spaced laterally from the center of the anode element to cause the free end of the wire to be arranged near and exteriorly of the anode element and overlapping the anode element, welding the wire to the anode element, paying out the wire toward the welding point and forming the wire at a portion thereof rearwardly of the welding point and after the welding to provide a single laterally extending loop only and an extension at one side of the loop and holding the formed parts after the forming action, shifting the anode element so that its center is brought into alignment with said extension, severing the wire at the extension after the forming action and while the formed parts are being held, and then releasing the anode element and formed parts for removal.

10. A method of forming a diode element, comprising supporting an anode element having a central longitudinal axis in a selected position, feeding a wide longitudinally toward the anode element and arranging the forward end of the wire in exterior overlapping relation with a portion of the anode element, the wire then extending longitudinally of the anode element and spaced laterally from its central longitudinal axis, engaging said forward end of the wire with a clamping welding electrode and welding said forward end to the anode element and continuing to clamp the forward end with the clamping electrode, bodily shifting the anode element laterally with the wire welded thereto so that the central longitudinal axis of the anode element is aligned with the line of feed of the wire, moving forming jaws into engagement with the wire rearwardly of the clamping welding electrode and paying out the wire toward the welding electrode to form in the wire a laterally extending loop and a longitudinal extension upon the side of the loop remote from said electrode, holding the longitudinal extension in accurate alignment with the central longitudinal axis of the anode element, and then severing said longitudinal extension close to corresponding sides of the jaws and while it is held by the jaws to complete the diode element.

11. A method of forming a diode element comprising supporting an anode element having a central longitudinal axis in a selected position, feeding a wire longitudinally of said anode element and spaced laterally from said central longitudinal axis toward the anode element and arranging the forward end of the wire in exterior overlapping relation with a portion of the anode element, clamping said forward end of the wire to the anode element and welding the wire to the anode element and continuing the clamping action after welding, bodily shifting the anode element with the wire welded and clamped thereto laterally in a direction for causing the central longitudinal axis of the anode element to be aligned with the line of feed of the wire, engaging the wire at a point

spaced from its point of welding and clamping point and paying out the wire toward the anode element and forming in the wire a generally U-shaped lateral loop and a longitudinal extension upon the side of the loop remote from the welding and clamping point and simultaneously holding the formed loop and extension to position the extension in accurate alignment with the central longitudinal axis of the anode element, and then severing the longitudinal extension while it is being held throughout its entire length to complete the diode element.

12. A method of forming a diode element, comprising supporting an anode element having a central longitudinal axis in a selected position, moving a wire longitudinally toward the anode element and arranging the forward end of the wire adjacent a side of a portion of the anode element, the wire then extending longitudinally of the anode element and spaced laterally from its central longitudinal axis, welding the wire to the anode element, moving forming jaws into engagement with the wire rearwardly of its point of welding to the anode element and paying out the wire toward the point of welding to form in the wire a laterally extending loop including a side arranged next to the anode element and a second side arranged remote from said anode element, severing the second side from the wire at a point remote from the anode element to provide said second side with a free end, and accurately positioning said free end in axial alignment with the central longitudinal axis of the anode element.

13. A method of forming a diode element, comprising supporting an elongated anode element having a central longitudinal axis in a selected position, feeding a wire longitudinally toward one end portion of the anode element, welding the forward end of the wire to said end portion of the anode element, effecting a relative closing movement between forming jaws so that they engage with opposite sides of the wire rearwardly of its point of welding to the anode element and paying out the wire toward the point of welding and thereby forming in the wire a laterally extending loop and a longitudinal extension upon one side of the loop, accurately aligning said longitudinal extension axially with said central longitudinal axis of the anode element, and then severing said longitudinal extension close to corresponding faces of the forming jaws while said jaws continue to hold said longitudinal extension in alignment with said central longitudinal axis.

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