Dec. 7, 1937. J. H. PAYNE 2,101,156

MACHINE FOR SEALING RECEPTACLES

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Fig. 2.

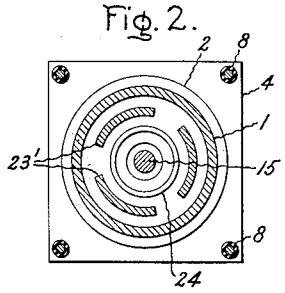


Fig. 1.

Fig. 3.

Fig. 6.

Fig. 4.

Fig. 5.

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Fig. 7.

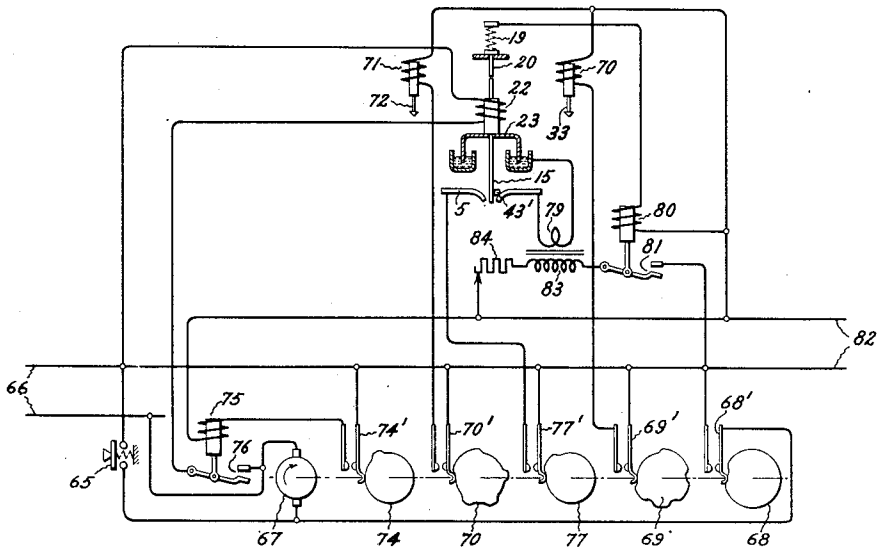
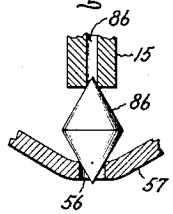


Fig. 8.



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2,101,156

MACHINE FOR SEALING RECEPTACLES

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Application April 28, 1936, Serial No. 76,796

15 Claims. (Cl. 219—4)

The present invention relates to the art of sealing hollow metallic receptacles, and more particularly to an improved machine for use in this art.

Although not limited thereto, the invention has been found to have special utility in the manufacture of electric switches of the liquid contact variety such as are described, for example, in my copending application, Serial No. 759,527, filed December 28, 1934. The switches therein disclosed typically comprise a closed vessel consisting of a pair of dished wall members of thin chrome-steel separated and insulated from one another by an apertured disk of nonconducting material, a body of mercury being arranged within the vessel to make and break an electrical circuit between the wall members. It is generally found desirable to provide an operating atmosphere of a reducing gas, such as hydrogen, which may be introduced into the vessel through a small aperture which thereafter is sealed off.

It is an object of the present invention to provide an improved machine by means of which the sealing aperture of a hollow receptacle of the class described may be closed while the switch receptacle is filled with a gas at a pressure materially different from atmospheric pressure.

It is another object of my invention to provide means whereby a fusible closure element can be supplied and positioned at will on the receptacle without releasing or changing the gas pressure in the receptacle.

It is another object of my invention to provide a receptacle-sealing machine which may be made to perform the successive steps in the sealing operation automatically and with a minimum of human supervision.

It is a further object of my invention to provide a receptacle-sealing machine capable of receiving any number of receptacles in succession; only an extremely simple transfer operation being required to substitute one receptacle for another.

One feature of the invention which contributes to the attainment of these objects includes the provision of a gas-tight chamber having a single opening adapted to be closed by the abutment of a workpiece to be sealed and having associated therewith pipe connections for introducing gas at a desired pressure.

In addition to the foregoing, a feeding mechanism is provided for supplying closure elements when required, the positioning of such elements being controlled by means entirely contained within the gas-tight chamber.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and the method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which Fig. 1 is an elevational view partially in section of a machine of my invention capable of being used in connection with my sealing process; Fig. 2 is a cross-sectional view taken on line 2—2 of Fig. 1; Figs. 3, 4, 5, and 6 are fragmentary sectional views illustrating successive steps in the sealing process; Fig. 7 is a schematic drawing of a control circuit for automatically producing the successive machine operations involved in the process, while Fig. 8 is a fragmentary sectional view showing an alternative mode of application of my invention.

Referring particularly to Fig. 1, I have shown a novel switch-sealing machine suitable for practicing my invention. An important aspect of the invention consists in the provision of a gas-tight chamber of which the main body is formed by a cylinder 1 of conducting material. This latter is partially closed at the bottom by an insulating plate 2 having at its periphery an upstanding flange 3 in tight-fitting contact with the outer surface of the cylinder 1. The plate 2 is held in position and reinforced by a suitably formed outer metal block 4 which in turn is kept in place by insulated bolts 8 secured to a heavy reinforcing ring 7. The block 4 and the plate 2 are both provided with central apertures, of which the former is partially closed by a depending cup 5 which projects considerably below the lower surface of the block. As will be hereinafter more fully explained, this cup comprises a welding electrode and preferably consists of a heat-resisting conducting material.

It will be noted that the circular aperture 6 provided at the base of the cup forms the only unsealed opening at the bottom of the enclosure assembly. In order that this opening may be closed by abutment of the face of a workpiece, I surround the electrode 5 by a resilient gasket 26 of resilient material such as rubber. With this arrangement, a gas-tight closure may be produced by the juxtaposition of a switch receptacle 27, which, as illustrated, is in the form of a liquid contact device of the type described in my aforementioned application, Serial No. 759,527. This is seated in a suitable recess in the mounting block 28 and is pressed into sealing contact with the gasket 26 by means of a strong compression spring 29 retained within a suitable alining cylinder 30, which in turn is supported on a base 30'.

The upper portion of the cylinder 1 is closed by a cup 11 of suitable insulating material threaded into the cylinder. This closure, which

is imperfect because of the air vents 12 in the lower portion of the cup 11, is completed by means of a hollow metal cylinder 13 threaded into the top of the cup. The cylinder in turn is closed at its upper end by a nut 14 screwed on to the same. The assembly of these parts is rendered essentially gas-tight by the use of lock nuts 16 and 17 threaded on to the external surfaces of the members 13 and 11, respectively.

As pointed out at the outset, the apparatus of my invention is intended to be used in sealing off metallic receptacles under a gas pressure different from that of the atmosphere. For this reason, a further important feature of the invention consists in the provision of means whereby the pressure in the enclosure described in the foregoing may be varied to meet desired conditions.

As illustrated, this means comprises a pair of gas-conducting pipes 31 and 32 brought through the walls of the cylinder 1. The pipe 31, for example, is adapted to be placed in communication with a vacuum chamber (not shown) by means of which the pressure within the enclosure cylinder 1 and the receptacle 27 may be reduced by the desired amounts. For controlling the opening and closing of the inlet to the pipe 31, I provide a solenoid controlled valve comprising a conical valve plunger 33 seating in a cylindrical aperture 34. The plunger 33 is retracted by a magnetic solenoid contained within a cylinder 35 and may be driven in the closing direction by a strong compression spring, (neither of these last-mentioned items being shown in the drawings).

Similarly, the pipe 32 is provided with a valve and a controlling solenoid, both of which are contained within the cylinder 36. However, whereas the pipe 31 has been described as connected to a vacuum chamber, the pipe 32 is intended to be placed in communication with a source of a reducing gas, for example, hydrogen, at a pressure materially different from atmospheric pressure. As will be pointed out more completely in the following only one of these pipes is intended to be open at a time.

For cooperating with the welding electrode 5 in the sealing operation, I provide a second electrode 15 concentrically mounted within the cylinder 1. The second electrode is freely movable in a vertical direction and is supported against horizontal displacement by a guide bearing 18 provided for that purpose in the bottom of the cup 11. A normally downward bias is supplied by means of a light compression spring 19 which acts on a metal follower 20 adapted to remain in contact with the electrode until just before it reaches its lowest position. Retractive motion of the electrode 15 is produced by means of a core 21 of magnetic material rigidly attached thereto. This is arranged at such a level that even in its lowest position it is within the influence of the magnetic field produced by solenoid coil 22. Consequently, whenever this coil is energized the core 21 and the electrode 15 are lifted until the former abuts against the lower surface of the cup 11.

Current from an external potential source connected to the cylinder 1 by means of the attached lead 7' is conducted to the electrode 15 through the legs of a contact device 23 rigidly mounted thereon. The depending legs 23' of the contactor project into a pool of mercury or similar conducting medium retained in a well formed for that purpose between the wall of the cylinder 1 and the cooperating wall of a concentric thimble 24. In this way, unimpeded motion of the electrode is made possible without interrupting its current supply.

In addition to the elements already described, my invention further provides a mechanism for introducing into the machine chamber single closure elements to be used in sealing off the workpiece (exemplified by the switch receptacle 27). As illustrated, this mechanism comprises a conduit 40, the lower portion 41 of which forms a chute projecting through the wall of the electrode 5. The upper portion of the conduit 40 is adapted to be placed in communication from time to time with a storage receptacle 42 which contains a supply of closure elements 43. For reasons which will be more fully explained in the following, these latter preferably comprise small spheres of a difficultly fusible metal having a melting point on the order of that of the switch material and which are capable of forming an integral weld with the same. Metals which are regarded as particularly suitable for this purpose include steel, chrome-steel alloys, and nickel, all of which are resistant to mercury corrosion.

For regulating the rate of feeding of the closure elements a simple control device is provided. This consists of a solid cylinder 44 (shown in section) interposed between the lower orifice 45 of the chamber 42 and the alined opening of the conduit 40. The cylinder 44 is provided at its circumference with a depression 46 adapted, when turned to a proper angular position, to line up with the orifice 45. The dimensions of the depression 46 are such that it will just accommodate one of the closure elements 43. It will thus be apparent that when the cylinder 44 is given a single complete turn by means of the crank 48, one and one only of the closure elements 43 will be transferred to the conduit 40, whence it will drop by gravity into the machine enclosure. Since the cylinder 44 is tightly journaled in the intermediate coupling member 42', it will be clear that this feeding operation may be carried out without releasing the gas content of the enclosing cylinder 1.

In order that the rotation of the crank 48 may also serve as a convenient means for initiation of the automatic operation of my improved switch sealing machine, I provide in mechanical connection therewith a gear 50. Through an interlocking gear 50' this is effective to actuate a mercury contact switch 51, or other suitable contact device, which may be used to start the operation of a drum controller. The same gear connection may also be used to turn a paddle 52 which intermittently agitates the closure elements 43 and prevents blocking of the outlet orifice. The composite structure just described may conveniently be supported by an angle iron 53 securely attached at its lower end to the heavy reinforcing ring 7.

The utility of the machine above described may best be understood by considering its application to a particular use in connection with my improved sealing process. In the manufacture of switches, such as that indicated in Fig. 1 by the numeral 27, it is convenient first to complete the switch assembly except for the provision in one of the receptacle walls of a small aperture 56. This is used in the final stages of manufacture to introduce into the otherwise closed receptacle the quantity of mercury (designated by a dotted line 55) needed for contact-making operations and to

permit the establishment of a desired gas pressure inside the switch during the sealing process.

In accordance with the present invention, the aperture 56 is located at the bottom of a depression formed by an inwardly bent portion 57 of the receptacle wall. As will be pointed out more fully in the following, this configuration has been found extremely useful in positioning the closure element employed in the sealing operation.

After the required amount of mercury has been introduced, the switch receptacle, which comprises the workpiece, is placed in tight fitting abutment with the gasket 26, as shown in Fig. 1. It will be noted that the lower face of the welding electrode 5 is tapered to match the depressed face of the apertured wall. By the cooperation of these parts, the central opening in the electrode 5 is effectively closed by the workpiece.

With the electrode 15 in the position shown, the crank 48 is turned to allow the introduction through the conduit 40 of a single closure element 43'. The passage of the closure element to the workpiece is obstructed by the lower end of the electrode so that the aperture 56 is at this time in open communication with the gas-tight enclosure formed by the cylinder 1 and its cooperating parts. A similar result may obviously be obtained by making the electrode 15 of such diameter as to block the opening of the chute 41 and prevent egress of the closure member.

In order to obtain a desired gas pressure in the switch receptacle, I may first energize the solenoid contained within the cylinder 35 to lift the valve plunger 33. By this action, the residual gas content of the machine enclosure and the switch vessel will be evacuated through the pipe 31. Subsequently, the valve 33 is closed, and the corresponding valve in the pipe 32 is opened to permit the introduction of hydrogen or other desired gas at a predetermined pressure. I have found it particularly advantageous in liquid contact switching devices to establish a pressure of from one to two atmospheres. If desired to insure the elimination of impurities, the alternate steps of exhausting and charging may be repeated several times.

When the required gas content has been established in the switch receptacle, the solenoid 22 is energized to lift the electrode 15 and permit the closure member 43' to roll into welding position on the workpiece. Due to the spherical nature of the member 43' and the converging form of the depressed area in the receptacle wall, the former is ideally adapted to center itself in the aperture 56 in the position illustrated in Fig. 3. It will thus be apparent that my invention provides means entirely within the gas-tight chamber whereby the closure element may be manipulated into a desired position without opening the chamber or otherwise releasing its gas pressure.

In proceeding to the welding operation, the solenoid 22 is deenergized to permit the electrode 15 to fall to a position where it will rest upon the top of the closure element 43. Since the compression spring 19 is extremely weak, the pressure of contact between the electrode surface and the surface of the closure member will be very light, scarcely exceeding the weight of the electrode itself. Furthermore, the lower surface 58 of the electrode is flattened so that its area of contact with the member 43' is extremely small, closely approximating a point contact. On the other hand, since the diameter of the sphere 43' is but slightly greater than that of the aperture 56, a relatively extensive contact area for the passage of welding current exists between the sphere and the receptacle wall. For this reason when an impulse of high amperage welding current is passed serially through the electrode 15, the closure element 43' and the receptacle wall portion 57 (whence it returns to the cooperating welding electrode 5), intense heating of the closure member is produced at its upper portion, with a minimum of heating at the portion in contact with the receptacle wall. As a result, local fusion occurs at the top of the ball causing the same to develop a mushroom portion 60 which flows outwardly over the cooler lower portion. This latter remains in a relatively unfused condition but is sufficiently heated to be forced down into the aperture 57, becoming integrally united with the walls of the same during the last instant that the welding current is permitted to flow.

In Fig. 6, I have illustrated the electrode and switch assembly as it appears at the instant the welding operation is complete. Since most of the parts shown correspond to those described in connection with the preceding figures, they are similarly numbered. It will be apparent from the drawings that the switch 27 now comprises a completely sealed enclosure consisting of two dished metallic receptacles 62 and 62', respectively, insulated by an apertured barrier 63 and peripherically sealed by a glass ring 64. The aperture in the upper wall surface of the receptacle 62 is hermetically closed by the fused member 43 which now comprises a portion projecting into the aperture and an upper enlargement which overlaps the edges of the aperture and is integrally united with the outer surface of the receptacle.

The foregoing mode of procedure has been found to result in a surprisingly small number of imperfect seals, due to the fact that the metal of the closure element is of high melting point and by the welding process is integrally united with the metal surrounding the aperture. The closure is inherently gas-tight and, since the sealing material preferably comprises a metal which is not attacked by mercury, the gradual corrosion of the seal no longer constitutes a limitation on the life of the switch.

In Fig. 7 I have shown a controlling mechanism by means of which the machine described above may be controlled to carry out automatically the steps of my improved process. In the use of this controller the sealing operation is initiated by closure of a push-button switch 65 (which may optionally be replaced by the switch 51 described in connection with Fig. 1 as being controlled by the rotation of the crank 48). The switch 65 completes a circuit from a direct current power source 66 for a servo-motor 67 which drives a drum or cam type contactor for controlling sequential operations.

The first motion of the motor 67 acts through a cam 68 and its cooperating contactor 68' to close a locking circuit which assures the continued energization of the motor through a full cycle of operations. An instant after this occurs, the first raised portion of a cam 69 passes under the movable element of a contactor 69' causing its circuit to be closed. This completes a connection from the alternating current power source 82 to energize a solenoid coil 70 which lifts the valve plunger 33 described in connection with Fig. 1. This serves to place the gas-tight enclosure of the sealing machine, as well as the

workpiece itself, in communication with a vacuum chamber or other exhausting means.

After a relatively brief period of operation, the occurrence of a depression in the cam surface of the cam 69 permits reclosure of the valve 33. At the same time, however, a raised portion on cam 70 comes into action to close contactor 70', energize the coil 71 and open valve 72. This second valve controls the inlet to the pipe 32 (Fig. 1) and permits filling the switch receptacle with gas at a desired pressure. It will be apparent that the cams 69 and 70 are formed to cause repeated alternate operations of the valves 33 and 72, respectively. Any desired number of operations may be obtained depending upon the design of the cam surfaces.

While the last gas admitting step is in process, a fourth cam 74 becomes effective to close a circuit from power source 82 for a solenoid 75 which in turn acts to close a contactor 76. In this way an energizing circuit from the power source 66 will be completed for the solenoid 22 corresponding to the similarly numbered element described in connection with Fig. 1. As previously explained, this solenoid acts to lift the welding electrode 15 to give the closure member an opportunity to drop into position on the workpiece. Since this requires but a fraction of a second, the raised portion of the cam 74 is of very short angular extent and permits the electrode 15 to be relowered into welding position almost immediately.

The welding step itself is under the control of a cam 77 and its associated contactor 77'. This cam, which is last to operate, completes an auxiliary circuit through the electrode 5, transformer secondary 79, contacting device 23, electrode follower 20, spring 19, and solenoid coil 80. The latter causes actuation of a contactor 81 thus completing a circuit from the power source 82 through the primary of the welding transformer 83 permitting a pulse of welding current to flow. This current will continue as long as the electrode 15 is in contact with the follower 20 maintaining the solenoid 80 in energized condition. However, as soon as the closure slug has fused sufficiently to permit the electrode 15 to reach the position shown in Fig. 1 its contact with the follower will be broken and the welding circuit interrupted by the opening of the contactor 81. The combination of the follower and electrode thus constitutes an automatic timing mechanism for the welding operation and by suitable dimensioning of parts will prove effective to regulate the welding current within very narrow limits. As a practical matter I have found that about a quarter of a second is sufficient to insure a good seal. The magnitude of the welding current, which flows in a low resistance circuit consisting of the transformer secondary 79, the welding electrodes 5 and 15, and the workpiece, may be regulated as to magnitude by a resistance 84 placed in series with the transformer primary.

While I have described my novel process as being preferably applied in connection with a spherical closure member, it should be understood that it is not necessarily limited thereto. On the contrary, the invention will be found to have equal utility in sealing with slugs of difficultly fusible metal of other shapes provided the welding current is passed through a small area of the slug remote from a more extensive region of contact with the receptacle to be closed. As illustrating such an alternative application I have shown in Fig. 8 a closure element 86 of essentially rhombic cross section having one apex seated in the seal-off aperture 56 and the other in a relatively small opening 86 provided for that purpose in the lower face of the welding electrode 15. It will be understood that due to the slight contact area existing between the electrode 15 and the slug 86, the initial fusion will be substantially localized at the upper part of the slug, thus causing the desirable mushrooming effect described in connection with Fig. 5.

Furthermore, while I have described a particular embodiment of my improved machine, numerous changes may be made therein without departing from the spirit of my invention. For example, it is possible and my invention contemplates that an automatic transferring mechanism in the nature of an intermittently operated continuous conveyor may be provided for substituting one switch for another at desired intervals, so that the entire sealing operation may be made entirely automatic. I therefore intend by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention. The sealing process described in the foregoing is not claimed herein but is fully described and claimed in my application, Serial No. 112,884, filed November 27, 1936, for a Process for sealing receptacles.

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

1. A machine for sealing metallic receptacles comprising a gas-tight chamber having a single opening therein adapted to be closed by abutment of the apertured face of a work-piece, a storage receptacle for retaining a quantity of closure elements for sealing said workpiece, and means operative from time to time for supplying single closure elements to said chamber from said storage receptacle while maintaining the former in substantially gas-tight condition.

2. A machine for sealing metallic receptacles comprising a gas-tight chamber having a single opening therein adapted to be closed by abutment of the apertured face of a workpiece, means for creating a desired gas pressure in said chamber, a storage receptacle for retaining a quantity of closure elements for said workpiece, and means for supplying single closure elements to said chamber from said storage receptacle without affecting the gas pressure of the chamber.

3. A machine for sealing metallic receptacles, comprising a gas-tight chamber having a single opening therein adapted to be closed by abutment of the apertured face of a receptacle to be sealed, means for sequentially evacuating and supplying gas to said enclosure and said receptacle, and means operative after said first-named means for positioning a slug of fusible material in the aperture of said receptacle and thereafter fusing said slug, said last-named means being entirely within said chamber.

4. A machine for sealing metallic receptacles comprising a gas-tight chamber having a single opening therein adapted to be closed by abutment of the apertured face of a receptacle to be sealed, means for sequentially evacuating and supplying gas to said enclosure and said receptacle, and means including a retractable welding electrode for thereafter positioning and fusing a closure element in the aperture of said receptacle, said last-named means being entirely within said chamber.

5. In combination, a first welding electrode adapted to be maintained in stationary contact

with a workpiece, a second welding electrode, means for moving said second electrode toward and away from such workpiece, and means including a feeding passage for supplying fusible slugs in cooperative relation with the workpiece, said last-mentioned means utilizing the motion of the said second electrode for uncovering the feeding opening of said passage to allow a slug to drop into welding position.

6. In combination, a first welding electrode adapted to be maintained in stationary contact with a workpiece, a feeding passage for supplying fusible slugs in cooperative relation with such workpiece, a second welding electrode normally positioned to obstruct the feeding opening of said passage, and means for moving said second electrode with respect to said opening to allow a slug to drop into welding position on the workpiece.

7. A machine for welding operations comprising a gas-tight chamber, an apertured welding electrode at the lower end of said chamber having a surface thereof externally exposed for abutment of a workpiece, a second electrode having a portion projecting outwardly through said aperture and mounted for reciprocating motion in said chamber, means for introducing a closure element into said chamber, means including said second electrode for temporarily preventing said closure element from passing through said aperture, and further means for moving said second electrode to permit said closure element to pass through said aperture into cooperative relation with said workpiece.

8. A machine for sealing metallic receptacles comprising a gas-tight chamber, an apertured electrode at the lower end of said chamber having a surface thereof externally exposed for contact with the face of a receptacle to be sealed, a second electrode having a portion thereof normally projecting into said aperture and mounted for reciprocating motion in said chamber, means for introducing a closure element into said chamber, means in communication with said chamber for varying the gas pressure therein, means for raising said second electrode to permit said closure member to pass through said aperture into cooperative relation with said workpiece and for thereafter lowering said second electrode into contact with said closure element, and means including an energizing circuit for passing heating current serially through said welding electrodes and said closure member.

9. A machine for sealing metallic receptacles comprising a gas-tight chamber, an apertured welding electrode at the lower end of said chamber having a surface thereof externally exposed for contact with the face of a receptacle to be sealed, a second electrode having a portion thereof normally closing said aperture, means for introducing a closure element into said chamber, means including conduits in communication with said chamber for cyclically varying the gas pressure therein, means for withdrawing said second electrode from said aperture to permit said closure element to move into cooperative relation with said receptacle, means including a follower for moving said second electrode into welding contact with said closure element, means including an energizing circuit for passing welding current serially through said electrodes and said closure element, and means including said follower for interrupting said energizing circuit after a predetermined motion of said second electrode.

10. A machine for welding operations comprising a vertically disposed cylindrical chamber, an externally projecting electrode closing the lower end of said chamber except for a central aperture therein, a second electrode arranged coaxially within said chamber and having a portion thereof adapted to project downwardly through said aperture, means including a magnetic solenoid for withdrawing said second electrode from said aperture, means including a follower for biasing said second electrode in a downward direction when said solenoid is deenergized, means including a mercury contactor for connecting said second electrode to a source of welding potential during downward motion thereof, and means including said follower for disconnecting said second electrode from said potential source after a predetermined downward motion of the electrode.

11. A machine for sealing metallic receptacles comprising a gas-tight chamber having a single opening therein adapted to be closed by abutment of a receptacle to be sealed, means for establishing a desired gas pressure within said chamber and receptacle, and means operative to feed a closure element into cooperative relation with the receptacle through said opening while maintaining the chamber in gas-tight condition.

12. A machine for sealing metallic receptacles comprising a gas-tight chamber having a single opening therein adapted to be closed by abutment of a receptacle to be sealed, means for creating a desired gas pressure within said chamber and receptacle, and means operative from time to time to introduce closure elements into said chamber while maintaining the chamber in gas-tight condition.

13. A machine for sealing metallic receptacles comprising a gas-tight chamber having a single opening therein adapted to be closed by abutment of a receptacle to be sealed, means for creating a desired gas pressure in the chamber and receptacle, and means for positioning a closure member in cooperative relation with the receptacle through said opening and for thereafter securing said member in sealing relation with the receptacle while maintaining the chamber in gas-tight condition.

14. A machine for sealing metallic receptacles comprising a gas-tight chamber having an opening therein adapted to be closed by abutment of a receptacle to be sealed, means for establishing a desired gas pressure in said chamber, means for introducing a receptacle closure element into said chamber without affecting the gas pressure therein, and means operative through said opening for positioning and sealing said closure element in sealing relation with said receptacle while maintaining the chamber in gas-tight condition.

15. In combination, a first welding electrode adapted to be maintained in stationary contact with a workpiece, said electrode having an opening therein, a second welding electrode movable through said opening into operative relation with the workpiece, means for moving the second electrode toward and away from the workpiece, and means for feeding fusible slugs through said opening into welding relation with the workpiece, said last-named means utilizing the motion of the second electrode to control the passage of such slugs through the opening.

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